



Overview

This section will address those parts of the steering system related to the:

- Steering wheel
- Steering column
- Power steering fluid requirements
- Steering gear (THP 60)
- Hydraulic steering pump

Appendices In This Chapter

Appendix 1. TRW Flushing the Steering System. This two page excerpt from TRW's Steering System Maintenance Guidelines includes full details and instructions on flushing the steering system.

Appendix 2. TRW Air Bleeding the Steering System. This two page excerpt from TRW's Steering System Maintenance Guidelines includes full details and instructions on bleeding air from the steering system.

Appendix 3. THP Steering Gear Service Manual. This TRW Service Manual includes design features, fluid information, an exploded parts diagram, torque specifications, general information and on-vehicle service for the THP steering gear.

Appendix 4. TRW Steering Maintenance. This TRW publication, entitled *Chart Your Way To Easy Steering*, provides a solid overview of potential steering problems, their diagnosis and correction.

Appendix 5. Poppet Adjustment. This TRW publication explains what poppets are, how they work and readjustment procedures.

WARNING *Hydraulic fluid must be handled, stored and disposed of in a manner consistent with all the applicable local, state, and federal guidelines concerning hazardous materials.*

The hydraulic pump for the power steering assist is flange mounted to the engine and gear driven. The configuration of hydraulic lines from the pump to the steering gear is dependent on whether the bus has a hydraulic brake or air brake system.

On All Americans equipped with air brakes, the power steering fluid flows from the reservoir to the pump, then to the steering gear, and returns directly to the reservoir.

On All Americans equipped with hydraulic brakes, the power steering fluid flows from the reservoir to the pump, to the power steering gear and then to the hydraulic brake power assist (booster). From there, the fluid returns to the reservoir.

CAUTION *The power steering fluid and the brake fluid are not the same. They must be kept separate. Use DOT-3 for the brake system and use Dexron III for the power steering fluid.*

TRW POPPET
ADJUSTMENT



TRW STEERING
DIAGNOSTICS



TRW THP
STEERING GEAR



TRW SYSTEM
AIR BLEEDING



TRW SYSTEM
FLUSHING



There are a number of acceptable hydraulic fluids approved for use in the power steering system, the system must be drained and flushed to use a different type of fluid (See **Appendix 3. THP Steering Gear Service Manual** for approved hydraulic fluids). Do not mix oils or fluids if you change the fluid.

The steering reservoir on an All American Forward Engine can be accessed by opening the drivers side front access panel. The hydraulic brake reservoir is located in the same area.

WARNING *The hydraulic fluid for the steering system and the brake fluid used in the brake master cylinder are not compatible and could result in a loss of steering or a loss of braking if incorrect fluids are used in either system.*

Steering System Operation

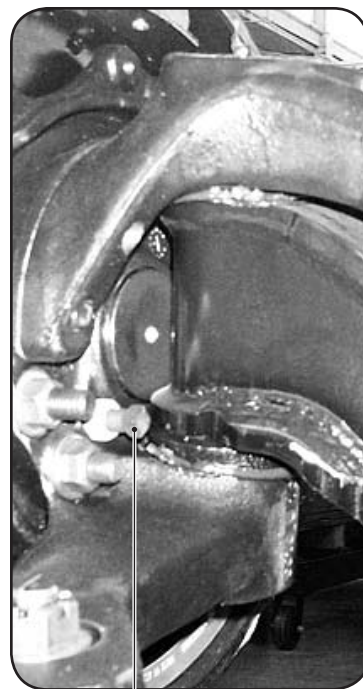
The speed at which the driver can turn the steering wheel with power assist is dependent upon the rate of flow provided by the hydraulic pump. (Normal flow rate is 3.6 - 6.3 gpm, Minimum flow rate is 2.9 gpm.) As the driver turns the steering wheel faster or slower, more or less oil flow is required by the gear. The pressure of the hydraulic fluid is used to overcome the resistance in the system. The higher the pressure, the more work it can perform. (Maximum operating pressure is 2,682 psi.)

The steering wheel is connected to the steering column shaft. The steering column shaft is connected to the steering gear input shaft. When the driver turns the steering wheel, the input shaft and worm shaft rotate. The worm shaft is in turn connected to a rack piston through the recirculating ball mechanism. This rotational movement moves the rack piston axially in the gear housing cylinder bore. The rack piston turns the sector shaft, which is connected by linkage to the wheels on the front axle.

As resistance is encountered in the steering effort, pressure in the steering hydraulic system will increase proportionally to assist the movement of the rack piston thus reducing the effort needed to steer the bus. As the input shaft is turned the control valve spool mounted on the torsion shaft (the torsion shaft connects the input shaft to the worm shaft) shifts and redirects oil flow to either side of the rack piston. A relief valve mounted on the valve housing limits maximum pressure to protect the power steering system. This is the primary pressure relief valve for the steering system. A secondary pressure relief valve is located in the hydraulic pump assembly on All American Forward Engine units.

Objectionable kickback is prevented due to the geometry of the steering gear. If the wheels receive a shock load from hitting rough areas in the road it is transmitted back through the sector shaft, rack piston, and worm gears. This load is neutralized by the control valve, which sends oil flow to the correct side of the rack piston to resist the shock forces. By absorbing the shock forces hydraulically the steering gear prevents objectionable kickback at the steering wheel and driver.

The steering gear is equipped with two poppet valves, one on each end of the rack piston. The poppet valves are set specifically to the turning radius of each bus after the axle stop adjustment has been made. When the steering wheels are turned and approach the axle stop, one poppet valve (depending on the direction of turn)



Axle Stops



trips. The tripped poppet valve opens allowing oil flow to bypass the piston which reduces pressure in the gear and helps reduce heat buildup in the hydraulic system. At the same time, the valves also reduce forces on the steering linkage.

Careful preliminary checks should be done to identify a steering problem and its symptoms before deciding the steering gear has failed. In most cases, the steering gear should be the last component suspected as cause of a steering problem.

Refer to the Appendixes in this chapter for detailed step by step troubleshooting procedures.

Steering System Maintenance

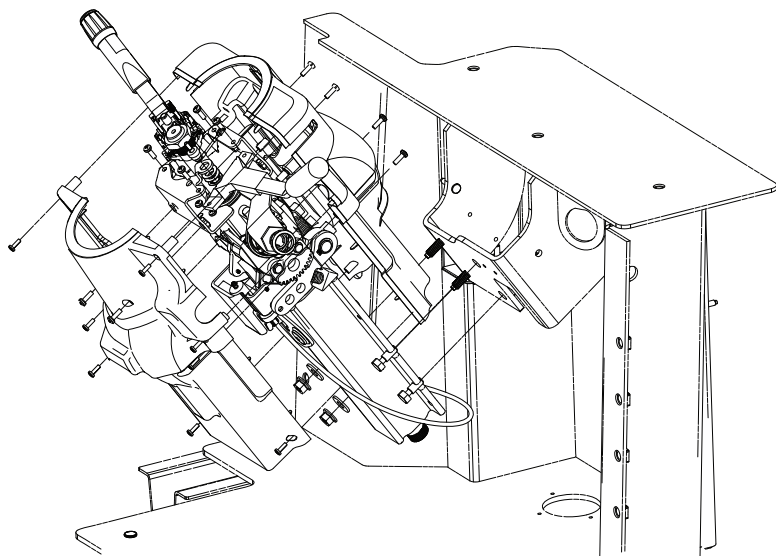
Before attempting to work on the steering gear, or any portion of the steering system, you must stabilize the vehicle. Read and understand the Warnings and Cautions in the General Maintenance chapter of this manual.

Regularly check the fluid level in the power steering reservoir. Change the fluid and replace the filter at the intervals specified in the Specs & Maintenance chapter. Clean around the reservoir filler cap before removing it. Dirt and other foreign matter can damage the hydraulic system.

Do not bend or straighten any steering component or linkage. Never attempt to weld any broken steering component. Do not use a torch to remove any steering component. Use only original equipment replacement parts.

Never use high pressure or steam to clean the power steering gear. Doing so can force contaminants inside the gear and lead to malfunction.

Proper alignment of the steering column is important to assure smooth steering. Correct the cause of any free play, rattle, or shimmy immediately to avoid damage to the steering system. Record and report any malfunctions or accidents which may have damaged steering components.



Steering Column Assembly

Setting the Steering Poppets

To adjust the steering poppets, refer to **Appendix 5 Steering Poppets** in this chapter.

Refer to the Front Axle Appendix located in the axle chapter of this manual for the following steering related adjustments and lubrication points:

- Axle Stop Adjustment
- Caster and Camber Adjustments
- Toe-in Adjustment
- King-Pin Lubrication
- Te-Rod Lubrication

Steering Column & Steering Wheel

Steering Column

The All American steering column offers a tilt/telescoping range of movement, allowing the steering wheel and stem controls to be placed within a comfort range of the driver. Adjustment of the steering wheel is accomplished by actuating a tilt/telescoping control lever, located at the bottom center of the steering column, and moving the steering wheel into a new position. The control lever is actuated by pulling downward until the lever rolls over center and locks in the release position. With the control lever in the released position the steering wheel and column moves freely within its range of travel. When the steering wheel has been placed in the desired position push the control lever upward to lock the position. Actuating the control lever allows up and down movement of the steering wheel for tilt control and in and out movement of the steering column for telescopic control.

When the control lever is actuated a set of lock paws in the tilt locking mechanism is released allowing the steering wheel and upper steering column to be positioned up or down in one of 9 detents (positions). When the control lever arm is released the lock paws reengages the detent providing a positive lock in the position selected. At the same time the tilt lock paw is released the telescoping lock pad is released allowing the upper steering column to slide in and out of the lower steering column support. This function provides an almost infinite height control (within its range of travel) of the steering wheel and upper column. When the tilt/telescoping control is released a friction pad mounted on the lower stationary support column makes contact with the upper column providing a non-incremental positive lock of the telescoping mechanism.

The steering column and its control mechanism is a self contained unit. Although it provides tilt and telescoping adjustment of the steering wheel and column there are no adjustments to steering column control mechanism. The steering column requires no lubrication and is considered a non-serviceable component.

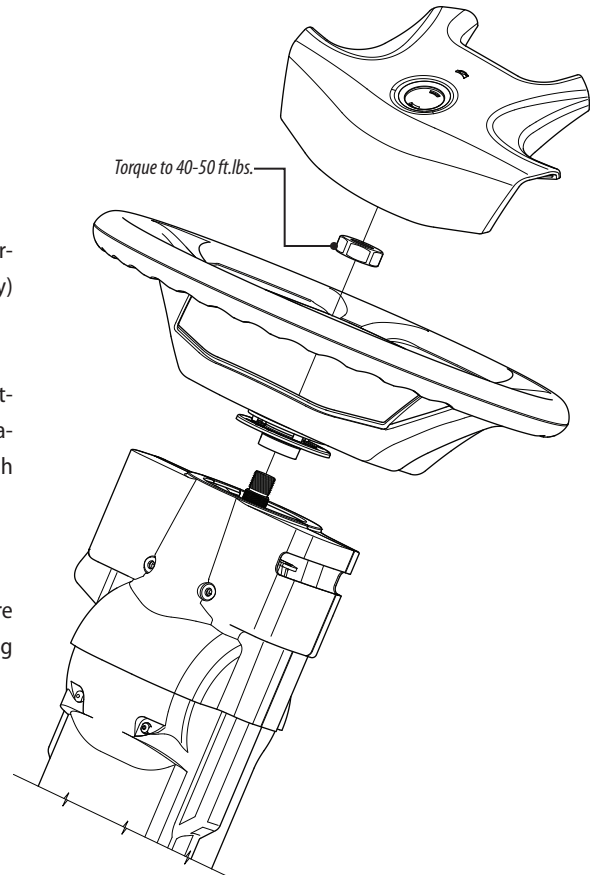
Some components attached to the steering column are serviceable i.e., turn signal switch, cruise control, ignition switch, and the horn brush contact. See details in the **Chassis Electrical** section of this manual.

**Steering Wheel Removal.**

1. Remove the screws retaining the steering wheel cover.
2. Lift the cover and disconnect any electrical circuits.
3. Check the alignment marks on the steering shaft and steering wheel flange (make new alignment marks if necessary) and remove the steering wheel nut.
4. Remove the steering wheel. The steering shaft and the mating flange on the steering wheel has splines but are not tapered. A rubber hammer may be required to provide enough force to loosen the connection.

Steering Wheel Reinstallation

To replace the steering wheel assembly, reverse the procedure above. Making sure the steering wheel is aligned with the steering shaft. Torque the steering wheel nut to 40 to 50 ft. lbs.



*Steering Wheel Installation
(Stems Not Illustrated)*

Steering Gear

The THP 60 is an integral hydraulic power steering unit. The steering gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder. The control valve senses steering requirement from the driver and directs oil flow to the appropriate cylinder cavity at the proper flow rate thus providing a smooth power assist steering.

The speed at which the driver can turn the steering wheel with power assist is dependent upon the rate of flow provided by the hydraulic pump. (Normal flow rate is 3.6 to 6.3 gpm, Minimum flow rate is 2.9 gpm.) As the driver turns the steering wheel faster or slower, more or less oil flow is required by the gear. The pressure of the hydraulic fluid is used to overcome the resistance in the system. The higher the pressure, the more work it can perform. (Maximum operating pressure is 2,682 psi.)

The steering wheel is connected to the steering gear input shaft. The input shaft is connected to a worm shaft. When the driver turns the steering wheel, the input shaft and worm shaft rotate. The worm shaft is in turn connected to a rack piston through the recirculating ball mechanism. This rotational movement moves the rack piston axially in the gear housing cylinder bore. The rack piston turns the sector shaft, which is connected by linkage to the wheels on the front axle.

As resistance is encountered in the steering effort, pressure in the steering hydraulic system will increase proportionally to assist the movement of the rack piston, thus reducing the effort needed to steer the bus. As the input shaft is turned, the control valve spool mounted on the torsion shaft (the torsion shaft connects the input shaft to the worm shaft) shifts and redirects oil flow to either side of the rack piston. A relief valve, mounted on the valve housing, limits maximum supply pressure to protect the power steering system. This is the primary pressure protection for the steering system. (A secondary pressure relief valve is located in the hydraulic pump assembly.)

Objectionable kickback is prevented due to the geometry of the steering gear. If the wheels receive a shock load, it is transmitted back through the sector shaft, rack piston, and worm gears. This load is neutralized by the control valve, which sends oil flow to the correct side of the rack piston to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel and driver.

The steering gear is equipped with two poppet valves, one on each end of the rack piston. The poppet valves are set specifically to the turning radius of each bus after the axle stop adjustment has been made. When the steering wheels are turned and approach the axle stop, one poppet valve (depending on the direction of turn) trips. The tripped poppet valve opens, allowing oil flow to bypass the piston, which reduces pressure in the gear and helps reduce heat buildup in the hydraulic system. At the same time, the valves also reduce forces on the steering linkage.

Careful preliminary checks should be done to identify a steering problem and its symptoms before deciding to tear down the steering gear. In most cases, the steering gear should be the last component suspected as cause of a steering problem.

Refer to Appendix 3, 4, and 5 in this chapter for detailed step by step troubleshooting procedures.



Steering Pump

The hydraulic steering pump on the Blue Bird All American Forward Engine is a positive displacement pump with an integrated pressure relief valve and a flow regulator valve.

When troubleshooting, it is important to remember to always do the simple steps first. Look for obvious signs of leaking, component wear or damage, and hose problems, before removing the power steering pump. Special attention should be given to the supply hose for signs of clamping or routing issues creating kinks in the hose that could restrict oil flow to the pump.

Using a flow meter, determine whether the pump is providing the necessary flow for proper steering. The steering pump should provide a flow of approximately 4 (minimum 2.9) gallons per minute (GPM). It is recommended that you use a Power Steering System Analyzer (PSSA) to assist in the diagnosis of steering system problems.

For details on troubleshooting the steering system, see **Appendix 4, TRW Steering Maintenance** in this chapter.

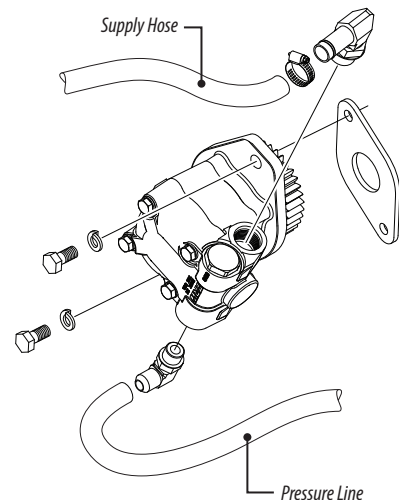
Steering Pump Removal (All American With Air Brakes)

1. Drain the system of fluid in a manner consistent with all local, state and federal laws. Wear protective gear when working with hydraulic fluids including eye protection.
2. Remove the supply hose .
3. Remove the pressure hose from the fitting at the output port of the pump.
4. Secure the pressure line safely out of the way.
5. Remove two capscrews from the hydraulic pump mounting flange.
6. Remove and discard the gasket.

Steering Pump Reinstallation (All American With Air Brakes)

Installation is accomplished in the reverse order of the removal instructions. Always install a new hydraulic pump gasket. Also install a new split ring lock washer and torque the mounting capscrews to 53–58 ft. lbs. (71.86–78.64 Nm).

After filling the reservoir, start and run the engine at idle for 10 seconds then switch the ignition off, refill the reservoir, start the engine and run for another 20 seconds, repeat this process until the reservoir maintains a full oil level. With the front wheels off the floor, (refer to **Jacking Procedures in the Specs & Maintenance** section of this manual) lifting by the axle not the wheels, start the engine and turn the steering wheel one direction and then the other direction a couple of times; then stop the engine and refill the reservoir. Perform this cycle until the reservoir maintains a full oil level.



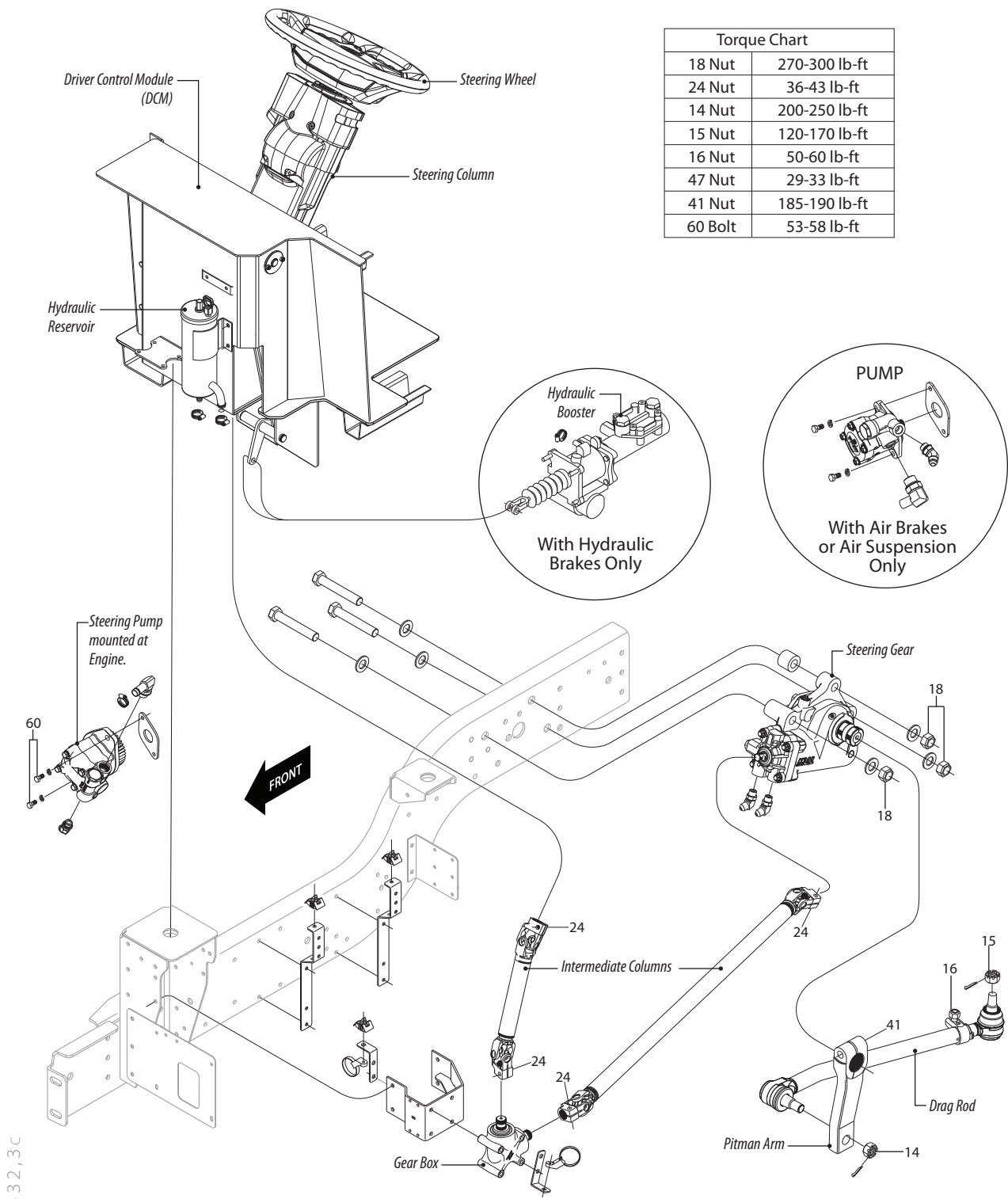
Test drive the bus and let the power steering fluid warm to operating temperature; then check the fluid level again. Check for leaks in the system.

Steering Pump Removal (All American With Hydraulic Brakes)

1. Drain the system of fluid in a manner consistent with all local, state and federal laws. Wear protective gear when working with hydraulic fluids including eye protection.
2. Remove the supply hose.
3. Remove the pressure line from the fitting at the output port of the pump.
4. Secure the pressure line safely out of the way.
5. Remove two capscrews from the hydraulic pump mounting flange.
6. Remove and discard the o-ring.

Steering Pump Reinstallation (All American With Hydraulic Brakes)

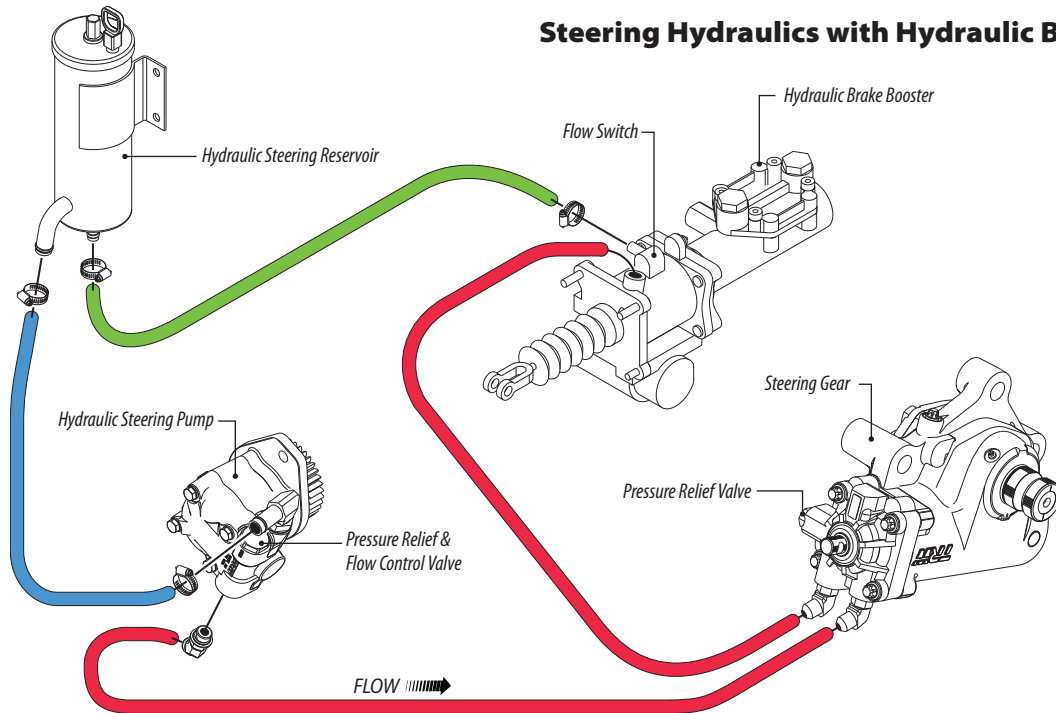
Install the pump in the reverse order of the removal. Ensure that a new o-ring is installed. Install a new split ring lock washer and torque the mounting capscrews to 53–58 ft. lbs. (33.32–44.74 Nm).



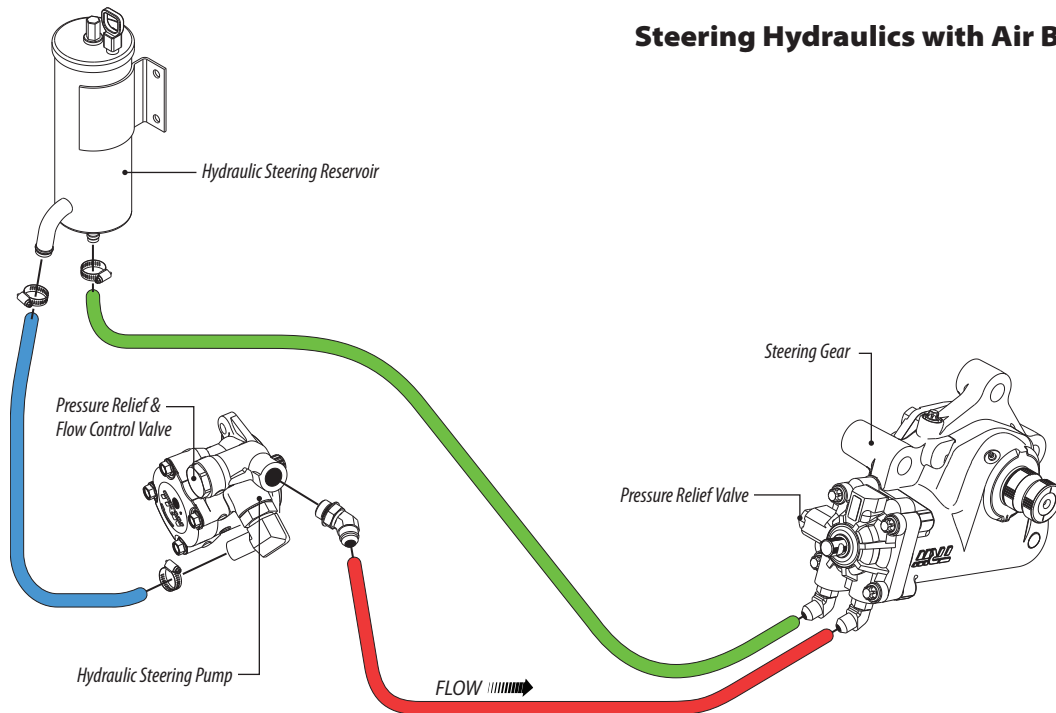
Steering Components

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Steering Hydraulics with Hydraulic Brakes



Steering Hydraulics with Air Brakes



774

Steering Schematics

0000432,3C


TRW

Flushing the Steering System

The steering system must be flushed every time a gear, pump, or reservoir gets replaced, regardless if the components are new or are remanufactured.

1. Set parking brake on vehicle and block rear wheels.
2. Raise the front end off the ground.
3. Take vehicle out of gear and put into neutral position.
4. Raise hood and wipe down area around the steering gear and the hydraulic lines related to the steering system.
5. Place a drip pan under the steering gear to catch the oil.
6. Remove both the pressure and return lines (Figure 1) from the steering gear and allow the oil to drain into the empty container.
7. Remove filter (Figure 2) from the power steering fluid reservoir and discard. Disconnect the supply line from the reservoir.
8. Rinse and clean the inside of the reservoir with an approved solvent, then air dry. Do not use a shop rag to wipe the inside of the reservoir and make sure that none of the solvent enters the rest of the steering system. If the reservoir is made from plastic inspect for cracks and damage. Replace if necessary.
9. Turn steering wheel from full left to full right 3-4 times. Collect the drained oil in the same container as in Step 6. This will purge the oil from the steering gear.
10. Reconnect pressure and return lines to the steering gear. Connect the supply line to the reservoir and then tighten all fittings.
11. Install new filter element into the reservoir.
12. Clean reservoir filler cap with an approved solvent. Inspect gasket and replace if necessary.
13. Inspect all hydraulic hoses (Figure 3) for cracks, soft or sweat spots and signs of local collapse (remove all covers/corrugated tubing from hoses to do this) and replace any that are found to be defective.
14. Check any banjo fittings and connectors for blockage. Clear any blockages using an appropriate method.
15. Filter contaminated oil through a coffee filter and examine for metal and foreign particles. Fine metal particles are evidence of normal wear and tear.



Figure 1

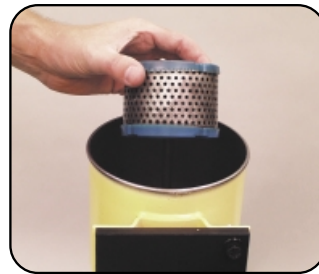


Figure 2



Figure 3



- Metal chips signify that the power steering pump needs to be replaced.
 - If black rubber particles are present; the inner lining of the pressure, return or suction lines may be disintegrating. Replace all three hoses.
16. Fill reservoir with approved replacement fluid and reinstall the filler cap (Figure 5).
 17. Start engine for 10 seconds, stop, and check reservoir fluid level and top off if necessary. You may need to repeat this procedure 3 or 4 times.
 18. Upon completion of filling the reservoir, start the engine and let it idle. At engine idle, steer full right and full left (Figure 6) once and return to straight ahead. Stop engine and check power steering reservoir level and top off if required.

CAUTION

Do not hold steering wheel at full turn for longer than 10 seconds as this will cause system to overheat.

19. Restart engine and steer full turns each direction 3 or 4 times.
20. Stop engine and recheck reservoir fluid level and adjust to correct level, if needed.
21. Inspect system for leaks and correct if necessary.
22. Bleed air from the system, if required.
23. Remove drip pan and lower vehicle. Remove blocks from wheels and return vehicle for normal service.



Figure 5



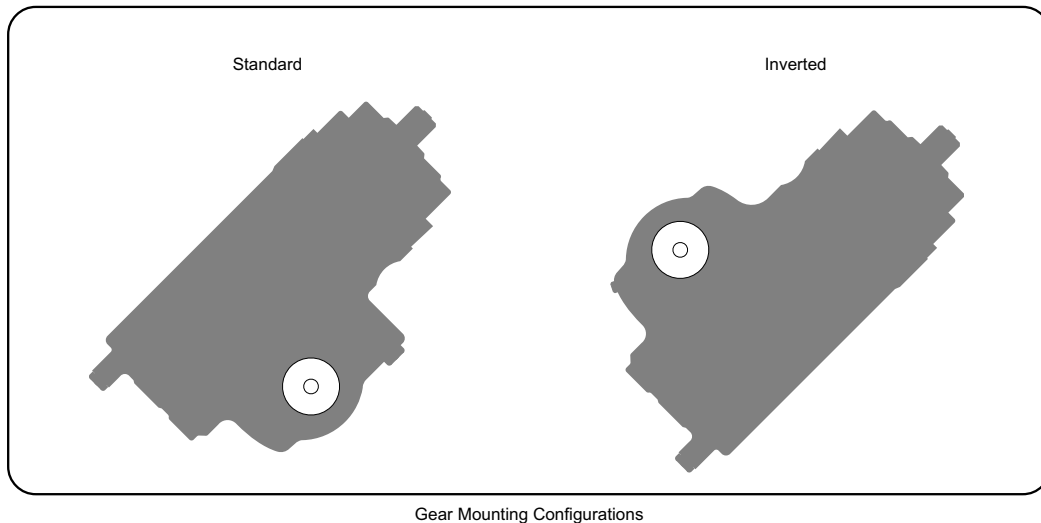
Figure 6


TRW

Air Bleeding the Steering System

Visual Identification

When you air bleed a steering system, you are simply allowing air trapped in the cavities of the steering gear to escape. As a general rule, if your steering gear is a "standard mount", you should use the Automatic Bleed method. If your gear is an "inverted mount", you will need to use the Manual Bleed method to purge the trapped air from the gear.



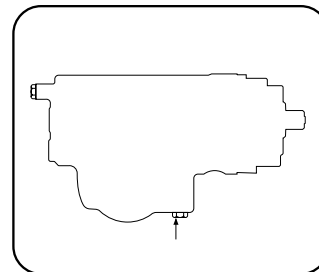
Automatic Bleed Gears

1. Fill the reservoir.
2. Start the engine, let it run for 10 seconds - without steering, then shut it off.
3. Check the reservoir, and refill if the fluid level has dropped.
4. Repeat at least three times, checking and refilling the reservoir each time if necessary.

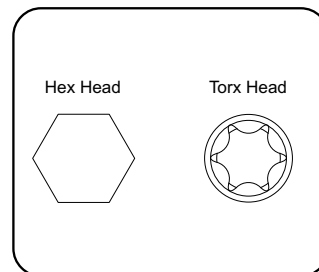
NOTE

Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.

5. Start the engine and let it idle for 2 minutes - without steering. Shut off the engine and check the fluid level in the reservoir. Refill if required.
6. Start the engine again. Steer the vehicle from full left to full right several times. Automatic bleed systems should now be free from trapped air.
7. Finally, be sure to check the fluid level in the reservoir. Refill if necessary before returning the vehicle to service.



Auto Bleed Plug Location



Auto Bleed Plug Styles



Manual Bleed Gears

1. Fill the reservoir.
2. Start the engine, let it run for 10 seconds - without steering, then shut it off.
3. Check the reservoir, and refill if the fluid level has dropped.
4. Repeat this process at least three times, checking and refilling the reservoir each time if necessary.

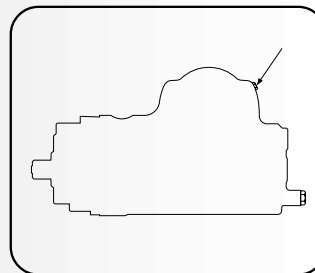
NOTE

Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.

5. Start the engine and let it idle for 2 minutes - without steering. Shut off the engine and check the fluid level in the reservoir. Refill if required.
6. Start the engine again. Steer the vehicle from full left to full right several times.
7. Again, check the fluid level in the reservoir.
8. With the engine idling, steer from full left turn to full right turn several times. Stop steering with the wheels pointed straight ahead and loosen the manual bleed screw 2-3 turns.
9. Allow air and aerated fluid to "bleed out" until fluid appears without bubbles.
10. Close the bleed screw, refill the reservoir if required.
11. Repeat this process three or four times until all the air is discharged. Torque manual bleed screw to 45 in•lb.

CAUTION

Do not turn steering wheel with bleed screw loosened.



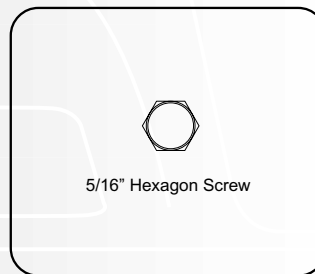
Manual Bleed Screw Location



Figure 1



Figure 1



5/16" Hexagon Screw

Manual Bleed Screw Style

TRW Automotive
Commercial Steering Systems
P.O. Box 60
Lafayette, Indiana 47902

Tel 765.423.5377
Fax 765.429.1868
<http://trucksteering.trw.com>
<http://www.trucksteering.com>

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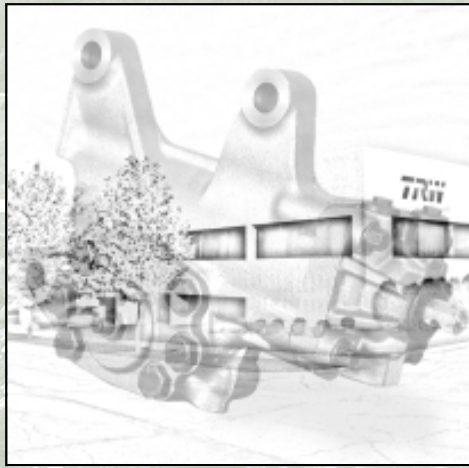


**TRW**

TRW Automotive
Commercial Steering Systems

THP/PCF Steering Gear Service Manual

THP / PCF 45 AND 60 SERIES

**779**

Hazard Warning Definitions

**WARNING**

A warning describes hazards or unsafe practices which could result in severe personal injury or death.

**CAUTION**

A caution describes hazards or unsafe practices which could result in personal injury or product or property damage.

NOTE

A note gives key information to make following a procedure easier or quicker.

Disclaimer

This Service Manual has been prepared by TRW Commercial Steering Systems for reference and use by mechanics who have been trained to repair and service steering components and systems on heavy commercial vehicles. TRW Commercial Steering Systems has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the TRW Commercial Steering THP/PCF Series Integral Power Steering Gears. Since this is a general service manual, the photographs and illustrations may not look exactly like the steering gear being serviced. The procedures, therefore, must be carefully read and understood before servicing.

If inspection or testing reveals evidence of abnormal wear or damage to the THP/PCF steering gear or if you encounter circumstances not covered in the Manual, STOP - Consult the vehicle manufacturer's Service Manual and warranty. Do not try to repair or service a THP/PCF steering gear which has been damaged or includes any part that shows excessive wear unless the damaged and worn parts are replaced with original TRW replacement and service parts and the unit is restored to TRW's specifications for the THP/PCF steering gear.



It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular THP/PCF steering gear to (a) inspect the steering gear for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the vehicle, or the safe operation of the vehicle, and (c) fully inspect and test the THP/PCF steering gear and the vehicle steering system to ensure that the repair or service of the steering gear has been properly performed and that the steering gear and system will function properly.

Patents

TRW Commercial Steering Systems THP/PCF power steering gears are covered by several United States and foreign patents, either issued or pending.



Design Features

- 1 **Size** - Reduced package size for increased wheelcut
- 2 **Weight** - Reduced weight for improved vehicle efficiency.
- 3 **Improved Steering Performance**
 - Faster steering ratio for improved handling and lower lock to lock turns
 - Low internal friction for better return to center
- 4 **High Pressure Capability** - Provides for the smallest and lightest package
- 5 **Positive Center Feel (Optional)**
 - Provides steering precision through improved straight ahead torque feedback (more stiffness) and improved position feedback control (less hysteresis)
 - Allows separation of parking efforts from on-highway efforts
 - Premium performance steering gear designed for line haul vehicles
- 6 **Design** - THP/PCF gear is based on the TAS model's proven steering gear technology plus:
 - Improved side cover design that reduces weight, package size, more robust seal, and a roller bearing to reduce friction and wear
 - Material and design changes made to operate at the higher pressure



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WARNING

All steering mechanisms are safety critical items. As such, it is imperative that the instructions in this booklet be followed to the letter. Failure to observe the procedures set forth in this pamphlet may result in a loss of steering.



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Introduction

This THP/PCF Service Manual applies to all TRW THP45, PCF45, THP60 and PCF60 steering gears.

This service manual reflects TRW's commitment to provide easily usable material and highly recognizable hazard notices. Some of the updates are:

- Caution and warning definitions
- Torque, force, pressure and flow notations that provide metric equivalents
- Service manual divided into sections for easier reference.
- Uninterrupted resealing instructions. Reference to damage section allows you to repair or replace damaged parts and return to the resealing procedures easily.

The three-column format used in the service manual will also help make it easy for you to service a steering gear. Column 1 illustrates the procedure with photographs, column 2 gives a brief key as well as tools to be used for each procedure, and column 3 explains in detail the procedure you should follow. **Pay special attention to the notes, cautions and warnings.**

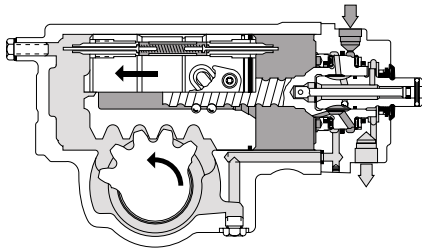
Item numbers on the exploded view correspond with item numbers in (), that are used throughout the service manual.

As you gain experience in servicing THP/PCF series steering gears, you may find that some information in this service manual could be clearer and more complete. If so, let us know about it. Don't try to second-guess the service manual; if you do not understand a procedure, or are stuck, contact our Field Service Department at 317.423.5377. Servicing THP/PCF series steering gears should be safe and productive.

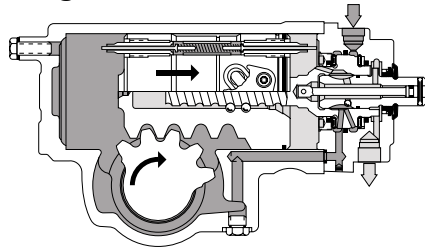


Oil Flow Illustration

Left Hand Lead

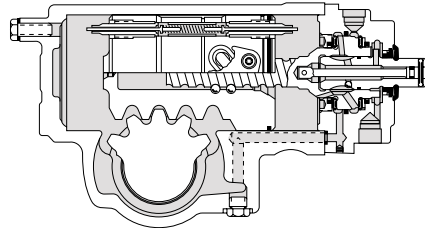
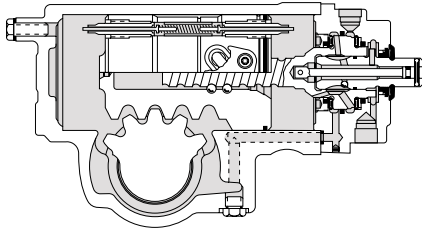
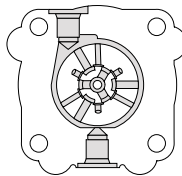


Right Hand Lead



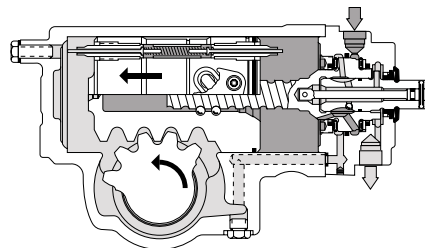
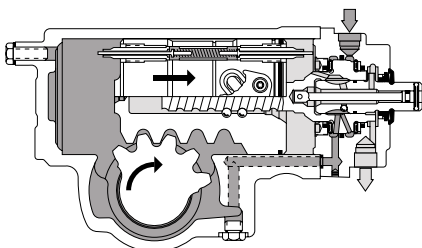
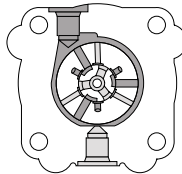
Right Hand Turn

Steering Wheel Input:
Clockwise Rotation



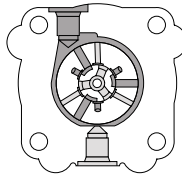
Straightline Running

No Steering Action



Left Hand Turn

Steering Wheel Input:
Counter-Clockwise Rotation



■ Supply Pressure

□ Return Pressure

General Design

Integral Power Steering

THP/PCF power steering gears are the latest design in the TRW Commercial Steering Systems' family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

The recommended minimum flow at 1½ steering wheel turns per second is as follows:

Gear	Minimum Flow Rate
THP/PCF45	2.2 gal/min (8.3 L/min)
THP/PCF60	2.6 gal/min (9.8 L/min)

Rotary Control Valve

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute or liters per minute) directed to a cylinder cavity. The control valve controls flow through the steering gear.

If the steering gear valve is controlling an auxiliary cylinder, increased minimum flow is required (generally at least 75%) based on the size of the auxiliary cylinder and the vehicle's steering geometry.

Maximum internal leakage for all THP/PCF gears is 1.2 gpm (4.5 lpm)

The pressure (measured in pounds per square inch, or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the appropriate cylinder cavity in the steering gear (and in the auxiliary cylinder if it is a dual steering system) at the proper flow rate and pressure.

Pressure Means Work, Flow Means Speed

The higher pressure a steering gear can withstand, the more work it can perform. The maximum operating pressure for all THP/PCF gears is 2685 psi (185 bar), maximum flow rate for all THP/PCF gears is 6 gpm (22.7 lpm).

The THP/PCF series gears can steer a vehicle within its front-end weight rating through a turn at low speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear. THP/PCF series vehicle front-end weight ratings are as follows:

Gear	Front Axle Rating
THP/PCF45	9,000 lb (4,100 kg)
THP/PCF60	14,300 lb (6,500 kg)



General Operation

What Happens During a Steering Maneuver

When the driver turns the steering wheel, he transmits force from the steering wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

Shock Loads to the Gear

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal geometry of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

Unloading (Poppet) Valves

Most THP/PCF gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage. These valves are automatically set to axle stops after installation in vehicle at first full right and left turn.

Relief Valve

Some THP/PCF gears, (with or without poppets), are supplied with a relief valve. The relief valve limits maximum supply pressure to protect the power steering gear, but it does not reduce pressure as the steered wheels approach the axle stops.

Bleed Systems

Some THP/PCF gears which are mounted with the output shaft above the rack piston bore are equipped with either an automatic bleed system or a manual bleed screw.

The procedure for air bleeding the system is on page 16 of this manual. Replacement of damaged automatic bleed plugs, and manual bleed screws is described on page 61.

Approved Hydraulic Fluids

Automatic Transmission Fluid Dexron II
Automatic Transmission Fluid Type "E" or "F"
Chevron 10W-40
Chevron Custom 10W-40 Motor Oil
Chevron Torque 5 Fluid
Exxon Nuto H32 Hydraulic Fluid
Fleetrite PSF (Can #990625C2)
Ford Spec. M2C138CJ
Mack EO-K2 Engine Oil

Mobil ATF 210
Mobil Super 10W-40 Motor Oil
Premium Blue 2000 - SAE 15W-40
Texaco 10W-40
Texaco TL-1833 Power Steering Fluid
Union 10W-40
Union 15W-40
Unocal Guardol 15W-40 Motor Oil

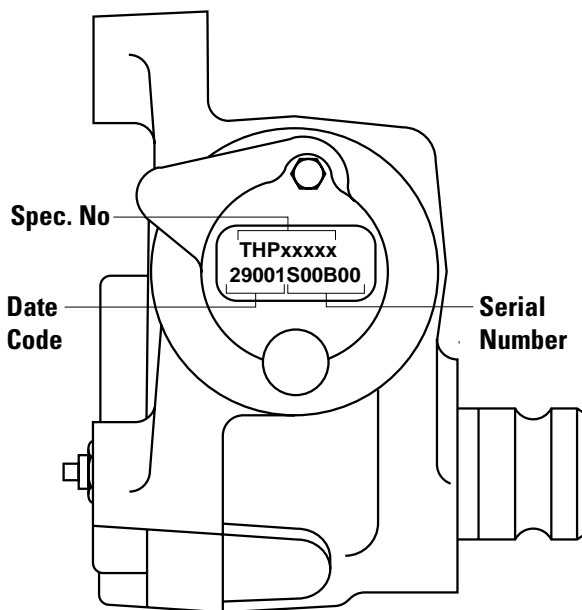
The steering system should be kept filled with one of the above fluids.

⚠ WARNING Completely flush the steering system with one of the recommended fluids above only. Do not mix oil types. Any mixture or any unapproved oil could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

Approved Grease

Exxon Polyrex* EP2 (P/N 045422)

Gear Specification Numbers



The steering gear specification number and date code are stamped on a machined surface opposite the input shaft of every THP/PCF gear.

An example date code would be 29001; this means the gear was built on the 290th day of 2001.

A letter suffix at the end of the specification number indicates a design level for the gear.



Torque Chart

Part Name	Item #	Torque Range Dry	Torque Range Lubricated
Valve housing bolts	1		118-138 ft•lb (160-187 N•m)
Auxiliary port plug	7	25-35 ft•lb (34-48 N•m)	
Relief valve cap	10	25-35 ft•lb (34-48 N•m)	
Bearing adjuster	20		11-15 ft•lb (15-20 N•m)*
Locknut	21		101-122 ft•lb (137-165 N•m)**
Poppet sleeve assembly	27	16-20 ft•lb (22-27 N•m)	
Torx screw	33	14-22 ft•lb (19-29 N•m)	
Plug, auto bleed	37	38-58 ft•lb (52-79 N•m)	
Poppet fixed stop screw	38	38-42 ft•lb (52-57 N•m)	
Sector shaft adjusting screw jam nut	46	40-45 ft•lb (54-61 N•m)	
Side cover bolts	48		180-220 ft•lb (244-298 N•m)
Poppet sealing nut, service	n/s	33-37 ft•lb (45-50 N•m)	
Manual bleed screw	n/s	40-50 in•lb (3.1-3.7 N•m)	

Item numbers referenced are shown on the exploded view located on page 8.

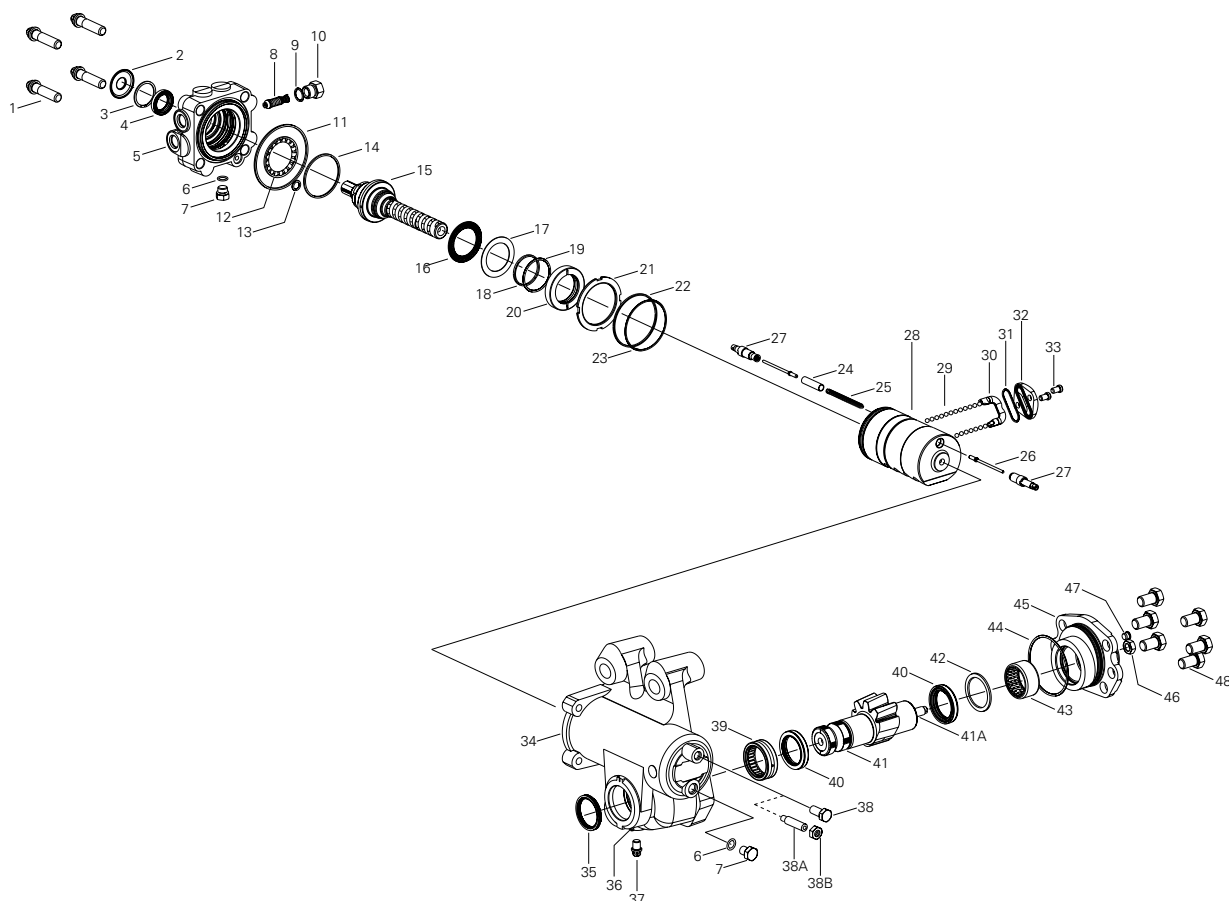
* After tightening to this torque value, the adjuster must be backed off $\frac{1}{4}$ to $\frac{1}{2}$ of a turn as described in step 20 on page 57.

**Torque value indicated is using recommended tools.

Special tools can be purchased through:

SPX Corporation
Kent-Moore Tool Group
28635 Mound Road
Warren, MI 48092
1-800-328-6657

THP/PCF Exploded View



Item Description

1	Valve Housing Bolts (4)	17	Thrust Washer	*35	Dirt and Water Seal (Trunnion)
*2	Dirt and Water Seal 13/16" Serr.	*18	Seal Ring	36	Grease Fitting
*2B	Dirt and Water Seal 7/8" Serr.	*19	O-ring	37	Plug (Auto Bleed)
*2C	Dirt and Water Seal 1" Serr.	20	Bearing Adjuster	38	Fixed Stop Screw (Poppet)
*3	Retaining Ring	*21	Lock Nut	38A	Poppet Adjusting Screw
*4	Seal (Input Shaft)	*22	O-ring	38B	Nut, Poppet Adjusting Screw
5	Valve Housing Assembly	*23	Seal Ring	39	Bearing, Roller
*6	Auxilliary Port O-ring (2)	24	Push Tube	*40	Seal (2-Output)
7	Auxilliary Port Plugs (2)	25	Poppet Spring	41	Sector Shaft Assembly
8	Relief Valve (2 Piece)	26	Poppet (2)	41A	Sector Shaft Adjusting Screw
*9	O-ring	27	Poppet Seat & Sleeve Assy. (2)	42	Washer
10	Relief Valve Cap	28	Rack Piston	43	Bearing, Roller
*11	O-ring (Valve Housing)	29	Balls	*44	Side Cover O-ring
12	Bearing Assembly	30	Ball Return Guide	45	Side Cover Assembly
*13	O-ring	*31	Seal (Cap)	46	Jam Nut
*14	Seal Ring	32	Ball Return Guide Cap	*47	Vent Plug (Side Cover)
15	Worm and Valve Assembly	*33	Torx Screw (2)	48	Bolts, Side Cover (6)
16	Thrust Bearing	34	Housing		

*These items are included in complete seal kits along with 045422 lubricant and a service bulletin.



THP/PCF Service Parts List

Common Parts

Item	Description	Part Number
1	Bolts (4-Valve Housing)	023037
2	Dirt and Water Seal 13/16" Serr.	478044
2B	Dirt and Water Seal 7/8" Serr.	478060
2C	Dirt and Water Seal 1" Ser	478050
3	Retaining Ring	401637
4	Seal (Input Shaft)	478076
6	O-ring (2-Aux. Port Plug)	032229
7	Auxiliary Port Plug (2)	415437-A1
9	O-ring (Relief Valve)	032200-153
10	Cap, Relief Valve	411061
11	Seal Ring	032829
12	Ball Bearing Assy.	400152-A1
13	Seal Ring (Valve Housing)	032823
14	Seal Ring (Valve Housing)	029128
16	Thrust Bearing	070027
17	Thrust Washer	400144
18	Seal Ring	029123
19	O-ring	032200-158
20	Bearing Adjuster	400149
21	Adjuster Locknut	027007
24	Push Tube	080154
25	Poppet Spring	401662
26	Poppet (2)	040248
27	Poppet Seat and Sleeve Assy. (2)	409118-A2
29	Balls	213684-X1
31	Cap, Seal	478042
32	Ball Return Guide Cap	400177
33	Torx Screws (2)	020228
36	Grease Fitting	037032
37	Plug, (Auto Bleed)	021397
37A	Screw, Manual Bleed	213705
38	Screw, Fixed Stop	021426
38A	Screw, Poppet Adjusting	
38B	Nut, Poppet Adjusting Screw	
44	O-ring, Sidecover	032856
46	Nut, Jam	025150
47	Plug, Vent (Side Cover)	036201
48	Bolts, Side Cover	021434

Parts Vary by Specification*

Item	Description
5	Valve Housing
8	Relief Valve
15	Input Shaft, Valve, Worm Assy.
28	Rack Piston
34	Housing
41	Sector Shaft (Includes 41A)
45	Side Cover Assembly (Includes 40, 42, 43)

*Contact Service/Sales for part numbers

Kits

Items	Description	Part Number
6 & 7	Port Plug & O-ring	415437-A1
9 & 10	Relief Valve Cap & O-ring	411061-A1
38A & 38B	Adj. Screw & Jam Nut	
	THP/PCF45 Kit	023045-X1
	THP/PCF60 Kit	021407-X1
2, 2B, 2C, 3, 4	Input Shaft Seal Kit	THP000001
	THP/PCF45 Seal Kit	THP450001
	THP/PCF60 Seal Kit	THP600001

Parts Vary by Gear Size

Item	Description	THP/PCF45	THP/PCF60
22	Rack Piston Seal Ring	032828	032830
23	Rack Piston O-ring	032827	032831
30	Ball Return Guide Halves (2) R.H.	400158	400172
	L.H.	400159	400173
35	Dirt and Water Seal (Trunnion)	478098	478095
39	Roller Bearing (Trunnion)	070030	071033
40	Output Seal (2)	478105	478104
42	Washer	028561	028557
43	Side Cover Roller Bearing	070031	071035
38	Fixed Stop Screw	023044	021426
38A	Poppet Adjusting Screw	023045	021407
38B	Poppet Adjusting Screw Nut	027018	025119

Section 2 Initial Installation

THP/PCF Installation	13
Initial Poppet Setting	13
Maintenance Tips	14



Initial THP/PCF Installation

- Bolt steering gear to frame, torque bolts to vehicle manufacturer's recommendation.
- Connect return line to THP/PCF gear return port.
- Connect hydraulic line from pump to pressure port on THP/PCF unit.
- Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
- Install pitman arm on output shaft, torque bolt to vehicle manufacturer's recommendation.

Initial Poppet Setting

For this procedure to work correctly, you must have: A new gear received from TRW or your vehicle manufacturer's aftermarket system, **or** a used gear on which poppet seats have been replaced or reset during gear disassembly procedures. **ALSO:** A fixed stop screw installed in the housing, or a poppet adjusting screw installed so that it duplicates the fixed stop screw length.

CAUTION The axle stops and all steering linkage must be set according to vehicle manufacturer's specifications, and the pitman arm must be correctly aligned on the sector shaft for poppets to be set correctly.

Full turn in one direction

1. With the engine at idle and the vehicle unloaded, turn the steering wheel to full travel in one direction until axle stop contact is made. Maximum input torque to be applied during this procedure is 40 lb rim pull (178 N) on a 20 in. (508mm) diameter steering wheel.

NOTE If you encounter excess rim pull effort, allow the vehicle to roll forward or jack up the vehicle at the front axle.

Full turn in other direction

2. Follow the same procedure while turning the steering wheel in the other direction. The poppets are now positioned to trip and reduce pressure as the steered wheels approach the axle stops in either direction.

Maintenance Tips

Never high-pressure wash or steam clean a power steering gear while on or off the vehicle. Doing so could force contaminants inside the gear and cause it to malfunction.

Do not attempt to weld any broken steering component.
Replace the component with original equipment only.

Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure pitman arm timing marks are aligned properly to **prevent internal bottoming** of the steering gear.

Do not cold straighten, hot straighten, or bend any steering system component.

Always **clean off around the reservoir filler cap** before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system.

Regularly check the fluid and the fluid level in the power steering reservoir.

Investigate and correct any external leaks, no matter how minor.

Keep tires inflated to correct pressure.

Replace reservoir filters according to requirements.

Never use a torch to remove pitman arm.

Investigate and immediately **correct the cause of any play, rattle, or shimmy** in any part of the steering system.

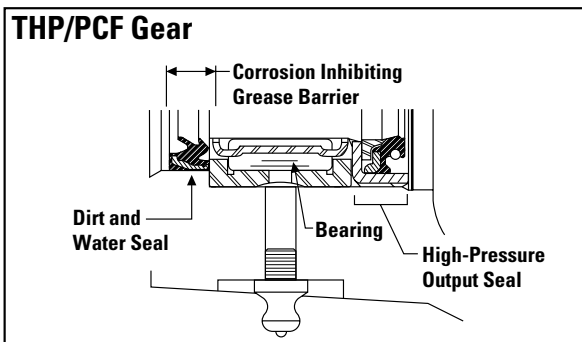
If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

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Make sure the steering column is aligned properly.

Encourage drivers to report any malfunctions or accidents that could have damaged steering components.

Maintain grease pack behind the output shaft dirt and water seal as a general maintenance procedure at least twice a year, in the Spring and Fall. Grease fitting is provided in housing trunnion. Use Exxon Polyrex EP2 (P/N 045422 or NLGI grade 2 or 3 multipurpose chassis lube, and use only a hand operated grease gun on fitting. Add grease until it begins to extrude past the sector shaft dirt and water seal.





Section 3 On-Vehicle Service

Filling and Air Bleeding the System	16
Input Shaft Seal Replacement	17
Sector Shaft Adjustment	21
Poppet Readjustment	
Single Gears	23
Dual Gears	26
Mirror Image	27
Reversed Image	29

Filling and Air Bleeding the System

Tools Required

5/16" Socket
in•lb Torque wrench

Materials Required

Hydraulic fluid



CAUTION

Make sure poppets are set correctly before beginning this procedure.

Run engine for 10 seconds, turn off and fill reservoir

Hydraulic fluid

1. Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time.



CAUTION

Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.

Run engine for 2 minutes, turn off and fill reservoir

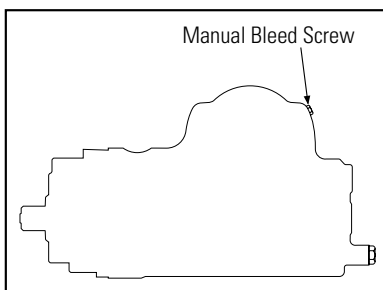
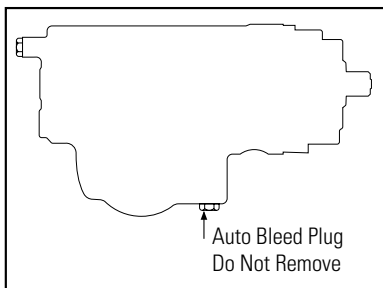
Hydraulic fluid

2. Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.

Steer vehicle

3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dip stick.

Automatic bleed systems should now be free from trapped air. **Manual bleed systems continue with step 4.**



Allow air to bleed out from bleed screw

in•lb Torque wrench
5/16" Socket

4. With engine idling, steer from full left turn to full right turn several times. Stop steering and loosen the manual bleed screw about one turn. Allow air and aerated fluid to "bleed out" until only clear fluid is seen. Close the bleed screw, refill the reservoir if required.

Repeat step 4 three to four times until all the air is discharged. Torque manual bleed screw to **45 in•lb**.



CAUTION

Do not turn steering wheel with bleed screw loosened.



Input Shaft Seal Replacement

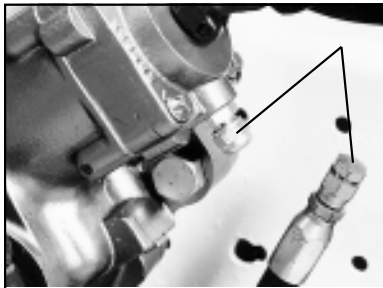
Tools Required

Hammer
J37073 Seal Driver
Screwdriver

Materials Required

Clean cloth
Drip pan
High pressure fitting
Hydraulic fluid
Plug
Shop towel

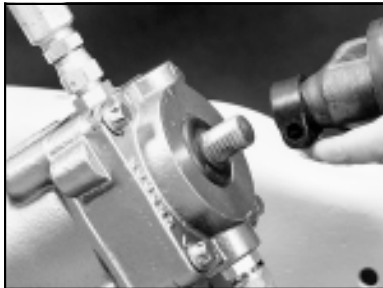
This procedure uses the vehicle's power steering pump to force out the input shaft seal. To use this procedure, the power steering pump should have a minimum of 1,500 psi available.



Disconnect return line

High pressure fitting
Plug

1. Disconnect return line from the steering gear and plug the line. Also cap the return port of the gear with a high pressure fitting.



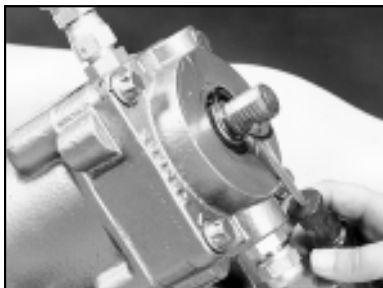
Disconnect column

2. Remove the steering column from the gear input shaft.



Remove dirt & water seal

3. Remove the dirt and water seal from the steering gear. Save this seal to match the new seal to the correct size.



Remove retaining ring

Clean cloth
Screwdriver

4. Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring. Be careful not to scratch the bore with the screwdriver.

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Replace column

5. Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.



Wrap exposed area

Drip pan
Shop towel

6. Tie or wrap a shop towel around the input shaft area and place a drip pan under the vehicle to catch the oil.



Fill reservoir

Hydraulic fluid

7. Add fluid as necessary, to the full line on the dipstick. Do not mix fluid types.

⚠ WARNING Any mixture of fluid types, or use of any unapproved fluid could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.

Force out the seal

8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).

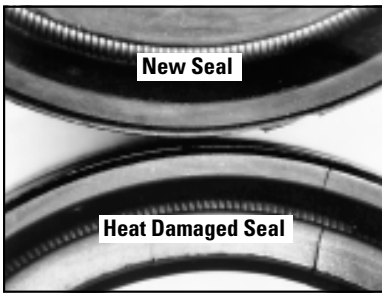


Remove input shaft seal

9. Remove the shop towel. Disconnect the steering column, and remove the input shaft seal.

**Inspect seal area**

10. Check the seal area of the valve housing for any seal fragments. Remove any that are found.

**Inspect old seal**

11. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. Determine and fix the cause of excessive heat in the vehicle.

**Install new seal**

Hammer
J37073 Seal
Driver

12. Put clean grease 045422 on the inside dia. of the new input shaft seal, and place it over the input shaft. With the small dia. of tool J37073 against the seal, tap the tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.



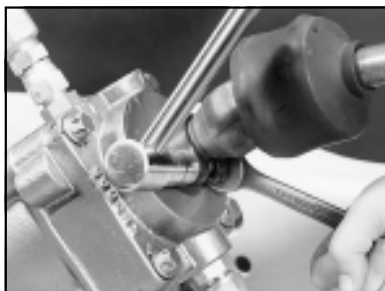
CAUTION Do not use a socket to install this seal because you will not be able to control seal installation depth, possibly causing a leak.

**Install retaining ring**

13. Insert new retaining ring into the groove.

**Install dirt & water seal**

14. Pack the end of the valve housing bore around the input shaft with grease 045422. Choose the correct size dirt & water seal by comparing the choices to the old seal, or by measuring the major diameter of the input shaft serrations (see chart next page). Apply more grease 045422 to the new dirt & water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.



Reconnect column

15. Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.



Reconnect return line

16. Reconnect the return line to the steering gear return port.

Air bleed system

17. Air bleed the system using the procedure on pg. 16.

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Seal Part No.	Serration Size	Major Serration Dia.
478044	13/16" x 36	0.807 / 0.799
478060	7/8 x 36	0.866 / 0.857
478050	1" x 36	0.987 / 0.977
478050	1" x 79	1.008 / 1.000



Sector Shaft Adjustment

Tools Required

Screwdriver
 $\frac{3}{4}$ " Socket
 $\frac{3}{4}$ " Open end wrench

Materials Required

This adjustment can only be completed on the vehicle if the adjusting screw jam nut is accessible. This nut is located on the side cover.

Photos in this section were taken on a mock frame rail for clarity.



Center the sector shaft

1. With the engine on, rotate the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the housing. The line on the sector shaft should be at a 90° angle from the input shaft. The sector shaft is now on its "center of travel". Turn the vehicle off.



Remove the drag link

2. Remove the drag link from the pitman arm.



CAUTION

To avoid resetting the poppets, do not rotate the input shaft more than 1½ turns from the "center of travel" position while the drag link is disconnected.



Check for sector shaft lash

3. From the "center of travel" position, grasp the pitman arm and gently try to rotate it back and forth. If looseness or lash is felt at this point, the sector shaft is out of adjustment.



Loosen jam nut

$\frac{3}{4}$ " Socket

4. Loosen the jam nut.

NOTE

If the gear is removed from the vehicle to adjust the lash:

- Leave the pitman arm connected to the gear.
- Best option is to follow the Final Adjustment procedure on page 62.
- Alternate option is to continue with step 5 of this procedure.



Position adjusting screw

Screwdriver



Adjust shaft

Screwdriver
3/4" Open end wrench



Recheck for lash



Connect drag link

5. If no lash was detected in step 3, turn the shaft adjusting screw counterclockwise until you feel lash at the output shaft.

6. Slowly turn the shaft adjusting screw clockwise until you feel no lash at the output shaft without using more than **10 ft•lb (14 N•m)** of torque. From this position, turn the screw clockwise $\frac{1}{8}$ to $\frac{3}{16}$ of a turn more. Hold the adjusting screw in place, and tighten the jam nut. Final jam nut torque **43 ft•lb (58 N•m)**.

7. Turn the steering wheel $\frac{1}{4}$ turn each side of center, then back to center and recheck the pitman arm for lash. You should feel no lash; if there is lash, repeat steps 4, 6 and 7.

8. Reconnect the drag link to the pitman arm according to manufacturer's specifications.



CAUTION

Maintain grease in the sector shaft bearing through the grease fitting in the housing using only a hand operated grease gun. Add grease until it begins to extrude past the dirt and water seal. Do not use a power grease gun because it will supply grease too fast; this could adversely affect the high pressure seal and contaminate the hydraulic fluid.



Poppet Readjustment - Single Gears

Tools Required

THP/PCF45	3/4" Open end wrench
6mm Allen wrench	3/4" Socket
19mm Open end wrench	5/8" Open end wrench
19mm Socket	ft•lb Torque wrench
18mm Open end wrench	Materials Required
THP/PCF60	Hydraulic fluid
7/32" Allen wrench	Jack

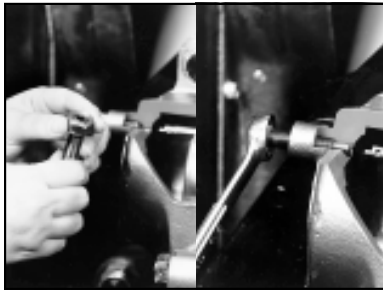
This resetting procedure will work in most cases with at least 1 3/4 hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.



Set axle stops, warm-up system

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

Start the engine and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.



Assemble adjusting screw into nut

2. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

Your steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already part of the steering gear, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.



Remove poppet stop bolt

THP/PCF45
18mm Open end wrench
THP/PCF60
5/8" Open end wrench

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of the housing.

If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.



Turn adjusting screw assembly into housing

THP/PCF45
6mm Allen wrench
19mm Wrench
THP/PCF60
7/32" Allen wrench
3/4" Wrench

4. Turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 6mm (THP/PCF45) or 7/32" (THP/PCF60) Allen wrench. Tighten the sealing nut against the housing.



CAUTION

If the drive end of the screw is below the face of the nut, the poppet seat flange will break during step 7d.



Refill reservoir

Hydraulic fluid

5. Refill the system reservoir with approved hydraulic fluid.



CAUTION

Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.



Jack up vehicle

Jack

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.



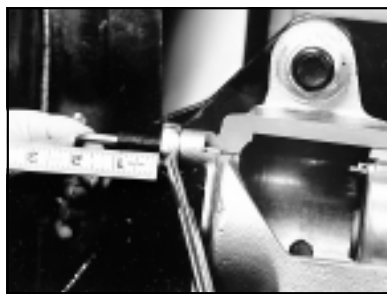
Push upper poppet out to prepare it for setting

7.
 - a) Start the engine and let it run at idle speed.
 - b) Note which output shaft timing mark is nearest the housing piston bore.
 - c) Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.
 - d) Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" dia. steering wheel) after the axle stop is contacted.



Set upper poppet

8.
 - a) Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.
 - b) Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" dia. steering wheel).
 - c) Release the steering wheel and shut off the engine.



Back out adjusting screw

THP/PCF45
6mm Allen wrench
19mm Wrench
THP/PCF60
7/32" Allen wrench
3/4" Wrench

9. Loosen the sealing nut and back out the adjusting screw until 1" is past the nut. Tighten the sealing nut against the housing.

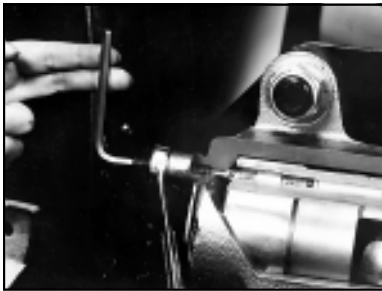


CAUTION

Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.

**Set lower poppet**

10.
 - a) Start the engine and let it idle.
 - b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.
 - c) Hold the steering wheel in this position (with up to 40 lb rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 11.

**Position adjusting screw**

THP/PCF45
6mm Allen wrench
19mm Wrench
19mm Socket
THP/PCF60
7/32" Allen wrench
3/4" Wrench
3/4" Socket
ft•lb Torque wrench

The procedure is complete

11.
 - a) With steering wheel held tightly at full turn loosen the jam nut and hold it in place with a wrench.
 - b) Turn the adjusting screw in (clockwise) using **finger-pressure only (don't use a ratchet)**, until the Allen wrench stops. Do not attempt to turn it in further. Pause the turning-in process each time the driver releases the steering wheel; continue turning only while the wheel is held at full turn.
 - c) Back off the adjusting screw 3/4 turns and tighten the sealing nut. Torque sealing nut to **35 ft•lb. (48 N•m)**
12. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

WARNING The length of the adjusting screw beyond the nut must be no more than 1 1/16" for proper thread engagement.

NOTE The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Poppet Readjustment - Dual Gears

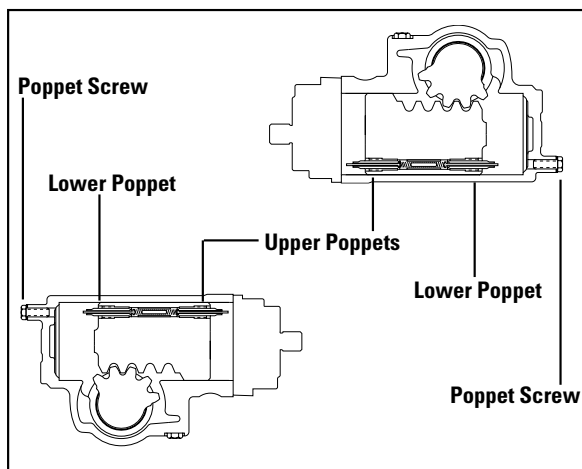
Mirror Image Systems and Reversed Image Systems

Before setting poppets on a dual gear system, you must determine whether the system has mirror image gears or reversed image gears. The procedures are slightly different for each type of system.

1. Park the vehicle with the wheels turned all the way to the axle stop in either direction. Turn the vehicle off.
2. Look at the output shaft timing mark nearest the housing piston bore on the master gear. Is this mark pointing toward the poppet screw or away from it?
3. Now check the same timing mark on the rotary cylinder. Does it point toward the poppet screw or away from it?

If they point to opposite ends of the gears you have a mirror image system, see pg. 27.

If they both point toward the poppet screws or both point toward the end opposite the poppet screws, you have a reversed image system, see pg 29.





Poppet Readjustment - Dual Gears - Mirror Image

Tools Required

THP/PCF45	¾" Open end wrench
6mm Allen wrench	¾" Socket
19mm Open end wrench	⅝" Open end wrench
19mm Socket	ft•lb Torque wrench
18mm Open end wrench	Materials Required
THP/PCF60	Hydraulic fluid
⅞" Allen wrench	Jack

This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

- Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

- If new poppet adjusting screws and nuts will be used, turn each screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

Your steering gear and rotary cylinder will both have either fixed stop bolts or adjusting screws. If the adjusting screw is already part of the gear or cylinder, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

- Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of housing on both the gear and the cylinder.

If either unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

- On both the master gear and the rotary cylinder, turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 6mm (THP/PCF45) or ⅞" (THP/PCF60) allen wrench. Tighten the sealing nut against the housing.

- Refill system reservoir with approved hydraulic fluid.

CAUTION Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.

- Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

- Start the engine and let it run at idle speed.

b) Turn the steering wheel in the direction that makes the timing mark on the master gear move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.

c) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

- Turn the steering wheel in the opposite direction (end of timing mark on the master gear away from adjusting screw) until the other axle stop is contacted.

b) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel).

c) Release the steering wheel and shut off the engine.

- Loosen the sealing nut and back out the adjusting screw on the master gear until 1" is past the nut. Tighten the sealing nut against the housing.


CAUTION Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.

- Start the engine and let it idle.

b) Turn the steering wheel in the original direction (end of timing mark on the gears toward adjusting screw), until axle stop contact is made.

c) Hold the steering wheel in this position (with 40 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing steps 11 & 12.

11. a) With steering wheel held at full turn, loosen the jam nut on the master gear and hold it in place with a wrench.
- b) Turn the adjusting screw in (clockwise) using **finger- pressure only** (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.
- c) Back off the adjusting screw $3\frac{1}{4}$ turns and tighten the sealing nut. Torque the sealing nut to **33-37 ft•lb.** (45-50 N•m)
- d) Release the steering wheel and shut off the engine.
12. Loosen the sealing nut and back out the adjusting screw on the rotary cylinder until 1" is past the nut. Tighten the sealing nut against the housing.
13. a) Start the engine and let it idle.
- b) Turn the steering wheel in the opposite direction (end of timing mark on master gear away from adjusting screw), until axle stop contact is made.
- c) Hold the steering wheel in this position (put up to 40 lb. rim pull on a 20" dia. steering wheel) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 14
14. a) With steering wheel held at full turn, loosen the jam nut on the rotary cylinder and hold it in place with a wrench.
- b) Turn the adjusting screw in (clockwise) using **finger- pressure only** (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.
- c) Back off the adjusting screw $3\frac{1}{4}$ turns and tighten the sealing nut. Torque the sealing nut to **33-37 ft•lb.** (45-50 N•m)
- d) Release the steering wheel and shut off the engine.
15. The poppets have now been completely reset. Lower the vehicle . Check the reservoir and fill if required.

 **WARNING** The length of the adjusting screw beyond the nut must be **no more than 1 $\frac{1}{16}$ "** for proper thread engagement.

NOTE The length of adjusting screw beyond the sealing nut may be different for each vehicle.



Poppet Readjustment - Dual Gears - Reversed Image

Tools Required

THP/PCF45	3/4" Open end wrench
6mm Allen wrench	3/4" Socket
19mm Open end wrench	5/8" Open end wrench
19mm Socket	ft•lb Torque wrench
18mm Open end wrench	Materials Required
THP/PCF60	Hydraulic fluid
7/32" Allen wrench	Jack

This resetting procedure will work in most cases with at least 1 3/4 hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

- Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

- If new poppet adjusting screws and nuts are being used, turn the screws into the non-sealing end of the jam nuts until the drive end of screw is flush with the nut.

Your steering gear and rotary cylinder will have either fixed stop bolts or adjusting screws. If the adjusting screw is already part of the steering gear or cylinder, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

- Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolts (if equipped) and washers (if equipped) from the lower end of housing on both the master gear and the rotary cylinder.

If the unit has poppet adjusting screws and sealing nuts that need to be replaced, remove and discard them.

- Turn the adjusting screws and sealing nut assemblies, without rotating the nut on the screw, into the housing until the nut is firmly against the housing, on both the master gear and the rotary cylinder, using a 6mm (THP/PCF45) or 7/32" (THP/PCF60) allen wrench. Tighten the sealing nut against the housing.

- Refill system reservoir with approved hydraulic fluid.

CAUTION Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.

- Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

- Start the engine and let it run at idle speed.

- Note which output shaft timing mark is nearest the housing piston bore.

- Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screws just installed on both the gear and the cylinder. Turn in this direction until axle stop contact is made.

- Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

- Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.

- Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel).

- Release the steering wheel and shut off the engine.

- Loosen the sealing nut and back out the adjusting screw until 1" is past the nut on both the master gear and the rotary cylinder. Tighten the sealing nuts against both housings.

CAUTION Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.

- Start the engine and let it idle.

- Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.

- Hold the steering wheel in this position (with 40 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing steps 11 and 12, first on the master gear, then on the rotary cylinder.

11.
 - a) With steering wheel held at full turn, loosen the jam nut on the master gear, and hold it in place with a wrench.
 - b) Turn the adjusting screw in (clockwise) using **finger- pressure only (don't use a ratchet)**, until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.
 - c) Back off the adjusting screw $3\frac{1}{4}$ turns and tighten the sealing nut. Torque nut to **33-37 ft•lb.** (45-50 N•m)
12.
 - a) With steering wheel held at full turn, loosen the jam nut on the rotary cylinder and hold it in place with a wrench.
 - b) Turn the adjusting screw in (clockwise) using **finger- pressure only (don't use a ratchet)**, until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.
 - c) Back off the adjusting screw $3\frac{1}{4}$ turns and tighten the sealing nut. Torque nut to **33-37 ft•lb.** (45-50 N•m)
13. The poppets on both the master gear and rotary cylinder have now been completely reset. Lower the vehicle . Check the reservoir and fill if required.

**WARNING**

The length of the adjusting screw beyond the nut must be **no more than $1\frac{1}{16}$ "** for proper thread engagement.

NOTE

The length of adjusting screw beyond the sealing nut may be different for each vehicle.



Section 4 Reseal & Repair

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Internal Damage Repair (by reference)

 Poppet Component Replacement 51

 Valve Housing Worm Screw Disassembly 53

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 Replace Housing Port Plugs, Screws, and Fittings .. 61

Final Adjustments 63

Disassembly Preparation

Stop the vehicle with wheels pointed straight ahead.

Clean off all outside dirt from around fittings and hose connections before you remove the gear.

Remove input and output shaft connections per vehicle manufacturer's instructions.

⚠ WARNING When using a chisel to spread a pinch bolt-type pitman arm boss for assembly or removal from the shaft, maintain a firm grip on the chisel at all times. Failure to do this may result in the chisel flying loose which could cause an injury. Never leave the chisel wedged in the pitman arm boss. If you cannot remove the pitman arm from the shaft with a chisel and your hands, remove the chisel from the arm boss and use a puller only to remove pitman arm.

⚠ CAUTION Do not use a hammer on the pitman arm to remove it from sector shaft as internal damage to steering gear could result. Be sure there is no spreading wedge left in the pitman arm boss before tightening pitman arm clamp bolt after assembly on sector shaft. Do not pound the universal joint or input shaft coupling on or off the input shaft as internal damage to the steering gear can result.

⚠ CAUTION Unless the poppet adjuster seat and sleeve assemblies (27) are to be removed and replaced or reset for automatic poppet adjustment, or a manual adjustment with a service poppet adjuster screw (38A) and nut (38B) is anticipated, do not allow the input shaft on a steering gear with the automatic poppet adjustment feature to rotate more than 1.5 input shaft revolutions from "straight ahead position" when the output shaft is disconnected from the vehicle steering linkage; this could disrupt the poppet setting achieved at initial installation. The steering gear is in the "straight ahead position" when the timing marks on the end of the housing trunnion and sector shaft are aligned.

Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

⚠ WARNING THP/PCF steering gears can weigh up to 70 pounds dry. Exercise caution when you remove, lift, carry, or fix in a bench vise.

Remove the steering gear from the vehicle and take it to a clean work surface.

Clean and dry the gear before you start to disassemble it.

As you disassemble the gear, clean all parts in clean, OSHA approved solvent, and air blow-dry them only.

⚠ WARNING Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

⚠ WARNING Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

⚠ CAUTION Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts. Use care that bearing and sealing surfaces are not damaged by the assembly and disassembly procedures.

Keep each part separate to avoid nicks and burrs.

Discard all seals, o-rings, and gaskets removed from the gear. Replace them with new parts only.

The steering gear should be identified to the vehicle from which it was removed. The poppet adjuster seat and sleeve assemblies are set for that particular vehicle only.



Disassembly

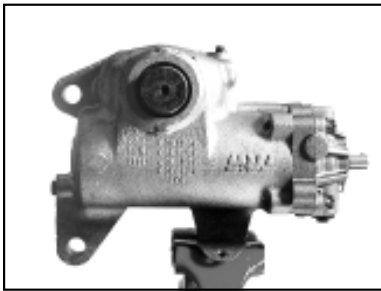
Tools Required

Allen wrenches
Pocket knife
Ratchet
Rolling head
pry bar
Rubber mallet

Screwdriver
Sockets:
•Standard
•Torx
Vise

Materials Required

Emery cloth
Masking tape



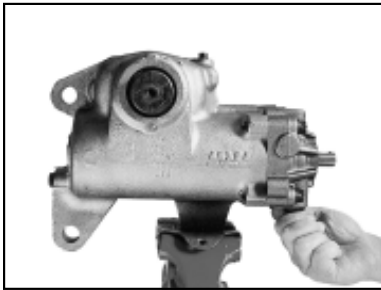
Position gear in vise

1. Put the steering gear in a vise, clamping firmly against the housing mounting flange or boss. Input shaft should be horizontal; side cover and valve housing are accessible for disassembly.



CAUTION

Do not clamp against body of housing. If mounting boss or flange is not accessible, fabricate and attach a mounting plate to the housing mounting bosses.



Unplug ports

Appropriate size
socket or open-
end wrench

2. Prepare for fluid drainage and unplug hydraulic ports.



Position sector shaft

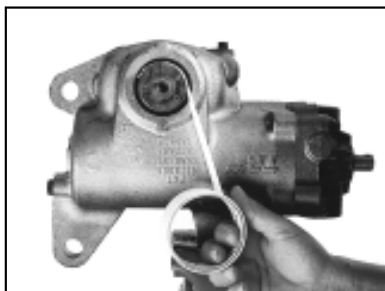
3. Rotate the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing. This will position the sector shaft for removal.



Clean sector shaft

Fine grade
emery cloth

4. Remove any paint or corrosion from the exposed area of the sector shaft (41).



Tape sector shaft

Masking tape

5. Tape the serrations and bolt groove of the sector shaft with one layer of masking tape. The tape should not extend onto the sector shaft bearing diameter.



Remove jam nut

$\frac{3}{4}$ " Socket

6. Remove the sector shaft adjusting screw jam nut (46).



Remove side cover bolts

$1\frac{5}{16}$ " Socket

7. Be prepared for more fluid drainage and remove the six bolts (48) from the side cover (45).

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Remove side cover

Soft mallet

8. Be prepared for more fluid drainage and remove the side cover and sector shaft assembly from the gear. You may start the shaft and cover assembly removal by tapping the end of the shaft lightly with a soft mallet or wooden hammer handle.



Discard O-ring

9. Remove and discard the side cover o-ring (44).

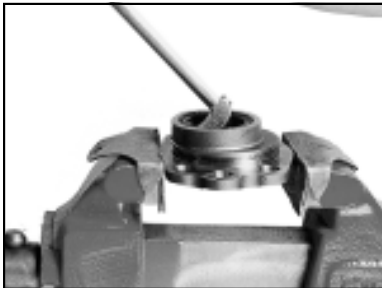
**Remove vent plug**

10. Remove and discard the vent plug (47).

**Remove sector shaft from cover**

Screwdriver

11. Turn sector shaft adjusting screw (41A) clockwise through the side cover and pull the sector shaft out of the side cover.

**Remove side cover seal and washer**

$\frac{3}{8}$ " Drive socket
Rolling head pry bar

- 12.

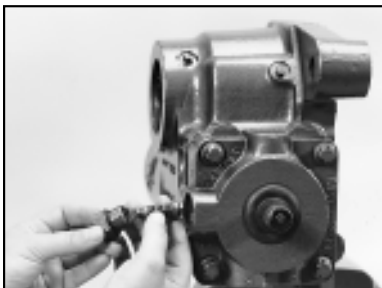
**CAUTION**

Don't damage the bore or bearing when removing the seal.

Clamp the side cover in a vise. Place a standard $\frac{5}{8}$ " or $1\frac{1}{16}$ " - $\frac{3}{8}$ " drive socket in the center of the side cover. Pry the seal (40) out with a rolling head pry bar, using the socket for support. Discard the seal and remove the socket. Remove washer (42).

**Inspect adjusting screw and retainer**

13. Inspect the sector shaft assembly for damaged adjusting screw threads. The retainer (41B, not shown) must be securely staked in place. The adjusting screw must rotate by hand with no perceptible end play (lash).

**Remove relief valve components**

$\frac{7}{8}$ " Socket

14. If equipped, remove relief valve cap (10), o-ring (9) and two-piece relief valve (8) from the valve housing. Discard the o-ring.



Remove dirt & water seal

15. Remove and discard the dirt & water seal (2, 2B or 2C) from the input shaft worm and valve assembly. Save this seal for comparison with the new seal.



Clean input shaft

Fine grade
emery cloth

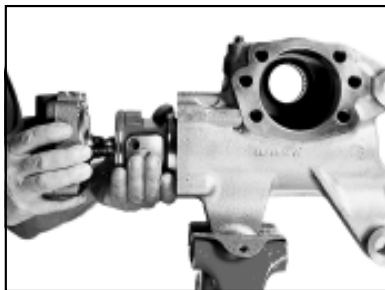
16. Clean any paint or corrosion from the exposed area of the input shaft.



Remove valve housing bolts

E-18
Torx socket

17. Remove the four torx head valve housing bolts (1).



Remove valve housing, worm and rack subassembly

18. Be prepared for more fluid drainage and remove the rack piston subassembly. Place the assembly on a clean cloth.

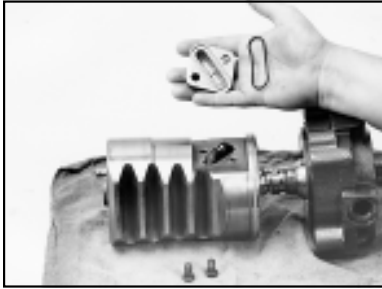
CAUTION The set position of poppet seat and sleeve assemblies (27) must not be disturbed if the poppets are not going to be replaced or reset during disassembly.



Remove seals

19. Remove and discard the valve housing seal rings (11 & 13).

CAUTION Do not remove the input shaft, valve worm assembly or balls from the rack piston until the ball return guides are removed as damage to the ball guides will occur.



Remove ball return guide cap

T-30 Torx wrench

20. Remove and discard the two special sealing screws (33). Remove the ball return cap (32) and seal (31), discard the seal.



Remove ball return guides

Screwdriver

21. Make sure the rack piston is on a cloth so the steel balls that fall out won't roll very far. Remove ball return guide (30) by carefully inserting a screwdriver between the rack piston and guides.

NOTE

Left hand ball return guide halves are plated with copper or zinc chromate for identification. Right hand guides are not plated. **Retain the guides for reassembly.**



Remove steel balls

22. Remove the steel balls (29) from the rack piston (28) by rotating the input shaft, valve worm assembly until the balls fall out. Place the balls and return guides in a cup or other container. Count the balls, and make sure all have been removed.



CAUTION

The steel balls are a matched set. If any are lost, the set must be replaced by service balls. Number of factory balls installed: THP/PCF45 - 29 balls, THP/PCF60 - 31 balls.



Separate rack piston from worm subassembly

23. Remove the input, worm, and valve housing subassembly from the rack piston.



Remove seal ring and o-ring

Pocket knife

24. Cut and remove the Teflon seal ring (23) and o-ring (22) from the rack piston.



Inspect poppet assemblies

25. Push poppet stems, they should spring back. Push poppet seat, it should not move by hand. If components are bent or broken, poppet stems don't spring back, or poppet seat moves by hand, go to **Poppet Component Replacement** section on page 51. Otherwise, proceed to step 26.

NOTE

TRW recommends the poppet adjuster seat and sleeve assemblies (27) not be removed unless replacement of poppet components is required.



Inspect valve housing and worm screw

26. Inspect valve housing/worm screw subassembly for heat damage or bearing roughness. If these conditions are present, or if there was excessive internal leakage, or if preload adjustment is required, go to **Valve Housing/Worm Screw Disassembly** procedures on page 53. If not, proceed to step 27.



Remove dirt seal

Screwdriver

27. Remove and discard the dirt and water seal (40).

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Remove pressure seal

Screwdriver

28. Insert a screwdriver through the trunnion opening, and carefully push the seal (40) out **without damaging the sealing area of the bore**. Discard the seal.

NOTE

A special hook groove has been machined into the bore to hold the seal in position. Clean out rubber from groove prior to installing new seal.



Inspect roller bearing

29. Inspect the roller bearing (39) for brinelling or spalling. If replacement is required, go to **Roller Bearing Replacement** - on page 60. If not, proceed to step 30.



**Inspect housing
screws, and plugs**

30. Inspect the following for damage:

- Poppet fixed stop screw (38)
- Poppet adjusting screw (38A) and sealing nut (38B)
- Auto-bleed plug (37)
- Manual bleed screw (Not shown)
- Auxiliary port plugs (7) and o-rings (6)

If any are damaged, go to **Replace Housing Port Plugs and Screws** on page 61. If not, proceed to the Inspection Section.

Inspection

Make sure all sealing surfaces and seal cavities are free from nicks and corrosion. Any nicked or corroded surface requires part replacement to ensure proper sealing.

Wash all parts in clean, OSHA approved solvent. Air blow them dry only.

⚠ WARNING Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

⚠ WARNING Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

⚠ WARNING Any of the following conditions present in the steering gear indicates impact damage.

Condition	Area
Brinelling	<ul style="list-style-type: none"> • Ball track grooves of rack piston • Ball track grooves of worm screw • Bearing area of sector shaft • Thrust washer and bearing in valve housing • Ball cup and bearing in valve housing
Cracks or Breaks	<ul style="list-style-type: none"> • Bearing area of sector shaft • Sector shaft teeth • Rack piston teeth • Housing • Thrust washer and bearing in valve housing • Worm screw • Ball cup and bearing in valve housing
Twisted serrations	<ul style="list-style-type: none"> • Output shaft serrations

If one of these conditions is found in one component, be sure to inspect all components carefully for signs of impact damage. Replace components noted in individual inspection steps below if you suspect impact damage. Failure to replace all damaged components could result in a serious vehicle accident.

820



Inspect rack piston teeth

1. Inspect the rack piston (28) teeth for cracks or obvious damage. If teeth are damaged, replace the rack piston, sector shaft (41) and set of balls (29).



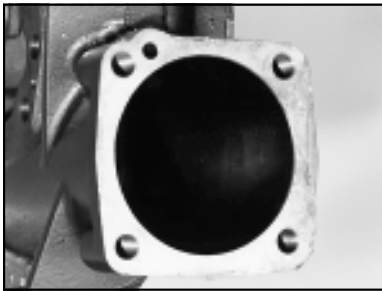
Inspect rack piston and worm ball track grooves

2. Inspect the rack piston (28) ball track grooves for brinelling or spalling. If either condition exists, replace the input shaft valve/worm assembly (15), valve housing (5), rack piston subassembly (28) and balls (29).



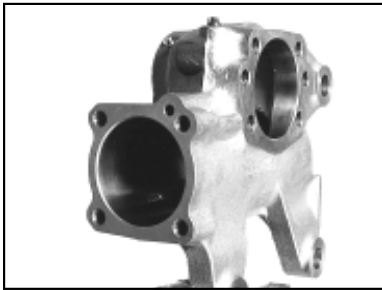
Inspect input shaft, valve/worm assembly sealing areas

3. Inspect the sealing area of input shaft and valve (15) for nicks, and damage. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, replace the input shaft, valve worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.



Inspect housing cylinder bore

4. Inspect the housing (34) cylinder bore. some scoring marks are normal. If there was internal leakage greater than 1.2 gpm (4.5 lpm), make sure there are no damaged seals before replacing the housing.



Inspect valve housing surface

5. Inspect the valve housing mating surface for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-tooth flat file without changing the dimensional characteristics.



Inspect side cover bearing

6. Inspect roller bearing in side cover assembly (45) for brinelling or spalling. If either condition exists, replace the side cover and bearing assembly.



Inspect sector shaft assembly

7. Inspect the sector shaft (41) bearing and sealing areas and sector teeth contact surfaces for brinelling, spalling or cracks. Run your fingernail edge across these areas to detect steps. Remove masking tape from the shaft and inspect for twisted or otherwise damaged serrations. If any of these conditions exist, replace the sector shaft.

NOTE

A service sector shaft will come assembled with the adjusting screw (41A) and retainer (Not shown).

Assembly Preparation

Wash all parts in clean, OSHA approved solvent. Air blow-dry them only.

WARNING Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.

WARNING Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.

Replace all seals, seal rings, and gaskets with new ones each time you disassemble the gear.

TRW Commercial Steering Division makes complete seal kits available. These parts can be purchased through most OEM parts distributors. Contact your local dealer for availability.

Assembly

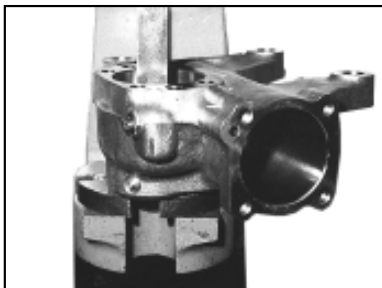
Tools Required

Hammer	Screwdriver
J37705 (THP/PCF45)	Sockets
J37071 (THP/PCF60)	Torx sockets
Press	Vise
Punch	Torque wrench
Ratchet	

Materials Required

ATF oil	Seal kit: THP450001
Grease (Exxon Polyrex* EP2)	THP600001
Masking tape	
14mm X 2.0mm	
All Thread	

Press seal into housing



J37705
(THP/PCF45)
J37071
(THP/PCF60)

4. **All gears** - Assemble new seal (40) onto bearing and seal tool (short end) so the lip with the garter spring is toward the shoulder of the tool. Working from the side cover side of the housing, pilot the seal tool into the washer and bearing and press with a force of 100-800 lb (445-3,560 N) until the seal is seated firmly.

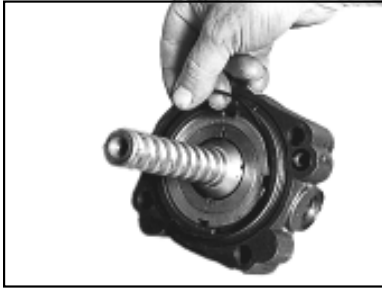
Install dirt & water seal



J37071
Press

6. Install the dirt & water seal (35) with the bearing and seal tool (long end), making sure it is not cocked. **Press the seal only until it seats against the bearing, don't push it in farther.**

Liberalily pack the roller bearing and new seals with clean, high temperature industrial grease, Exxon Polyrex EP (P/N 045422).



Assemble seal rings

3. Lightly oil new seal ring (11) and assemble in valve housing mounting face groove. Then, oil new seal ring (10) and assemble in valve housing (5) mounting face groove.



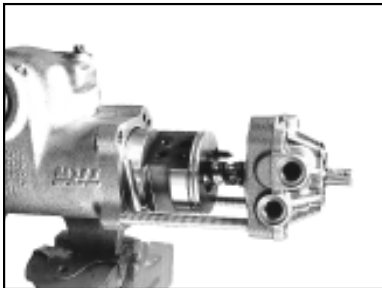
Install rack piston o-ring and seal ring

4. Install a new backup o-ring (22) and then a new Teflon seal ring (23) on rack piston (19). Do not over-stretch these rings as you install them. Do not allow the Teflon seal ring to be twisted.



Position rack piston in housing

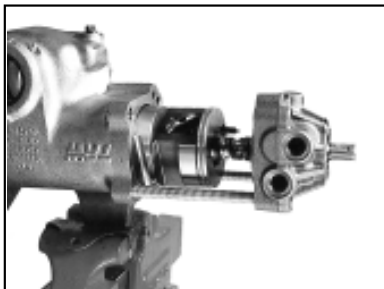
5. Apply clean oil to housing cylinder bore. Place the rack piston (28) in the housing piston bore with ball return guide holes up.



Insert worm and valve assembly into rack piston

14mm x 2.0mm
All Thread

6. Insert the worm screw into the rack piston close to maximum depth, without the valve housing making contact with the poppet stem. Insert two 14 mm x 2.0 mm All Threads through valve housing bolt holes and tighten into housing to support the worm screw. Line up rack piston ball guide holes with the worm ball track grooves by rotating the input shaft.



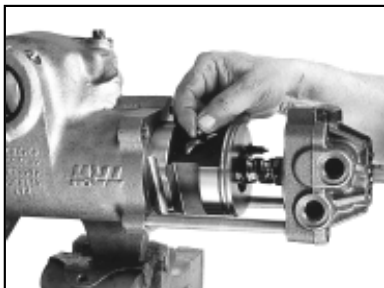
Assemble ball return guide halves

7. Assemble the ball return guide (30) into the rack piston until seated, rotate the input shaft slightly if necessary.

⚠ WARNING Do not seat guides with a hammer. Damage to guides can result in subsequent lockup or loss of steering.

⚠ CAUTION If a new rack piston (28) or a new input shaft, valve, worm subassembly (15) is being assembled, the balls (29) removed from the unit must be discarded and a service ball kit utilized. The balls in a service ball kit are sized to function in the ball track guide path as altered by component replacement.

⚠ CAUTION When using the service ball kit, use the correct quantity of service balls: THP/PCF45 - 29 balls, THP/PCF60 - 31 balls.



Assemble balls

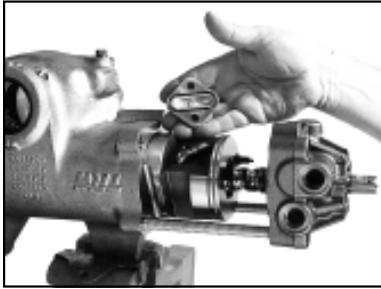
8. **Hold the ball return guide (30) firmly in place during this entire procedure.** Insert as many of the steel balls as you can through the hole in the top of the ball return guides. Rotate the input shaft to pull the balls down and around the ball track guide path. Continue until the correct number of balls are in the ball track guide path.

⚠ WARNING Hold down the ball return guides until cap is reinstalled. Failure to hold the guides will result in a trapped ball or balls, which could cause a vehicle accident. If the ball guide becomes unseated (raises) at any time, repeat the procedure starting at step 7.

⚠ WARNING The correct number of balls are required for proper gear operation. Count the balls and insert each carefully as in step 7. Number required: THP/PCF45 - 29 balls, THP/PCF60 - 31 balls.

⚠ CAUTION Do not allow valve housing to contact the poppet stem or move more than 2½ inches (69.1 mm) from upper end of rack piston during these procedures. This could incorrectly reset the poppet, or back out worm beyond closed ball loop, trapping balls.

⚠ CAUTION Remove any fluid present in the two screw holes. Fluid in these holes could cause improper clamp load when torquing the cap.

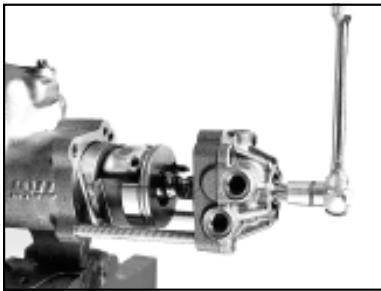


Assemble ball return guide cap

T-30 Torx
socket
in•lb Torque
wrench
Grease

9. Place a new ball return guide cap seal (31) in the seal groove of the cap (32). Make sure the seal makes full contact with the rack piston surface. Install two new Torx head screws (33) and torque each screw alternately until a final torque of **18 ft•lb** (24.5 N•m) is achieved.

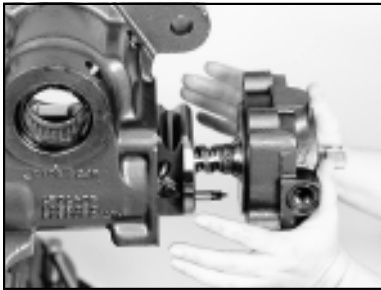
CAUTION Ball cap seal is greased to hold seal in groove while assembling. Be sure not to trap the seal outside of the groove during reassembly.



Rotate input shaft to check for proper installation of balls

10. Rotate the input shaft from one end of travel to the other without contacting the poppet stem to the valve housing, and without moving the valve housing face more than 2½" (69.1 mm) from input end (upper end) of rack piston. If you cannot rotate the input shaft, remove the balls and reassemble them.

WARNING If you install a gear on a vehicle with the worm shaft unable to rotate, the gear will not function correctly. Steering and gear failure may result.



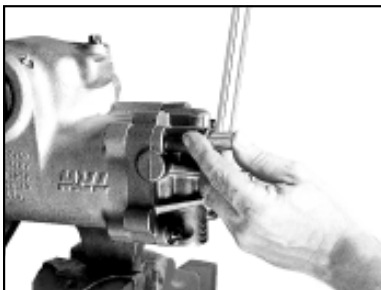
Install rack piston, worm, valve assembly

Oil

11. Apply clean oil to Teflon seal ring (23) on rack piston. Make sure there is a space of ⅜ - ½" (10.0-13.0 mm) between valve housing (5) and poppet stem to prevent poppet contact at either end. Remove the All Threads, and push the rack piston assembly into the housing with the rack piston teeth toward the sector shaft cavity. Line up the valve housing cylinder feed hole with the gear housing feed hole. Make sure both o-rings in the valve housing remain in position.

CAUTION Do not damage the seal ring (23) while installing the rack piston into housing.

CAUTION The poppet seat and sleeve assemblies (27) must not bottom against the internal poppet stops in the steering gear until the gear is installed on the vehicle and the poppet adjustment procedures are performed.



Install valve housing bolts

E-18 Torx
socket
ft•lb Torque
wrench

12. Lubricate and install the four valve housing bolts (1) into the housing. Torque the bolts to **118-138 ft•lb** (160-187 N•m).



Install relief valve parts

7/8" Socket
ft•lb Torque
wrench

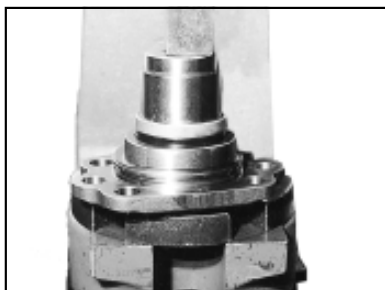
13. If the gear is equipped with a relief valve, assemble a new o-ring (9) on relief valve cap (10). Assemble the small end of tapered spring onto the pin on the relief valve cartridge and insert the assembly (8), (large end of tapered spring end first) into the relief valve cap cavity. Turn the relief valve cap as assembled into the valve housing and torque to **30 ft•lb (41 N•m)**.



Lubricate side cover bearing

14. Apply a generous amount of Exxon Polyrex* EP2 (TRW P/N 045422, do not substitute another type of grease) to the caged bearing assembly inside the side cover. Next, install washer (42) on top of bearing before inserting the seal (40).

CAUTION This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use the proper grease could result in premature bearing wear.



Press seal in side cover

J37705
(THP/PCF45)
J37071
(THP/PCF60)
Press

15. Grease and assemble new seal (40) onto installation tool so the side with the garter spring is against the shoulder of the tool. Pilot the tool into the side cover (45) with a force of 100-800 lb (445-3560 N) until it is seated against the bearing or bushing.

CAUTION Make sure the OD of the seal, and the ID of the bore are free from grease and dust, for proper engagement of the seal.



Lubricate sector shaft

16. Apply a generous amount of Exxon Polyrex EP2 (P/N 045422) to the short bearing area of the sector shaft.



Install sector shaft into side cover

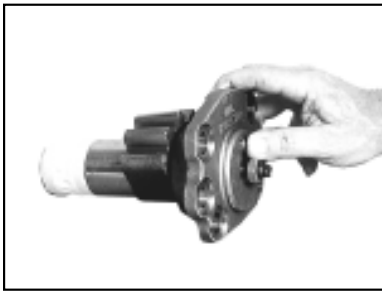
Screwdriver

17. Insert the sector shaft (41) into the side cover subassembly (45), and turn the sector shaft adjusting screw (41A) counterclockwise into the side cover until the screw reaches solid height.

Rotate the adjusting screw clockwise one half turn so the side cover will rotate freely on the sector shaft.

**Install jam nut**

18. Install the sector shaft adjusting screw jam nut (46) onto the sector shaft adjusting screw (41A) a few threads. Final adjustment will be made later.

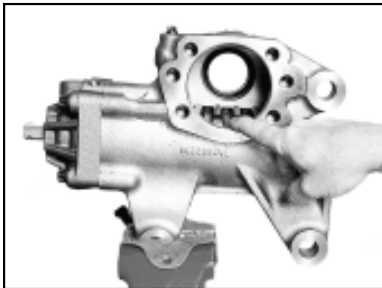
**Assemble vent plug**

19. Press the new vent plug (47) into the hole provided in the side cover until the plug is bottomed.

⚠ WARNING Do not weld or otherwise plug this hole in any permanent manner. This is a safety vent which functions only if the side cover seal fails. If the seal fails and the plug cannot vent, the steering gear may lock-up or otherwise malfunction.

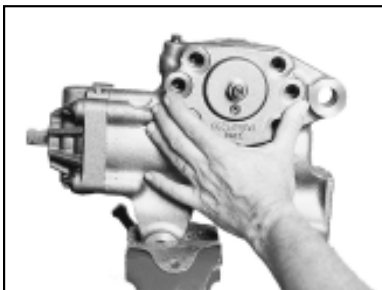
**Install side cover o-ring**

20. Apply clean oil to the new side cover o-ring (44) and assemble it onto the side cover (45).

**Center rack piston**

21. There are four teeth on the rack piston. Rotate input shaft to position the rack piston so the space between the second and third tooth is in the center of the sector shaft opening. This will center the rack piston for assembly of sector shaft.

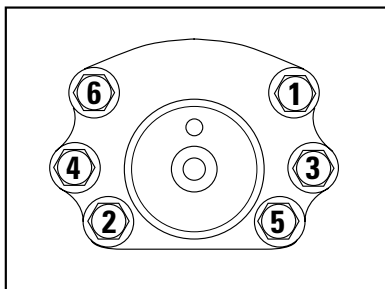
⚠ WARNING If the rack piston is not centered when sector shaft is installed, gear travel will be severely limited in one direction. This could result in an accident.

**Install sector shaft and side cover into housing**

Masking tape

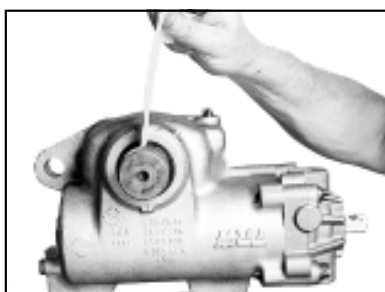
22. Clean off any old tape on the serrations. Reapply one layer of masking tape. Install the sector shaft assembly into the housing. The center tooth of the sector shaft must engage the center space (between the second and third tooth) of the rack piston. Lightly tap on sidecover with a rubber hammer to seat cover against housing face.

⚠ CAUTION If the serrations are not properly taped, they will damage the output seal (41) in housing, causing the seal to leak.

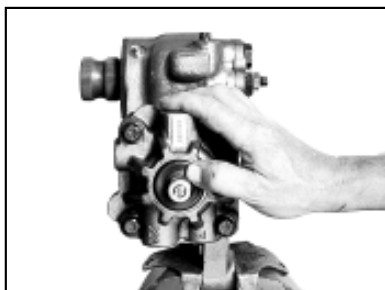


Install side cover bolts

$1\frac{5}{16}$ " Socket
Torque wrench



Remove tape



Install dirt & water seal

Grease

23. Install bolts in positions 3 and 4 first, by hand. Then, install the remaining side cover bolts (48) into the side cover and torque them in the sequence shown. If bolts must be replaced, use bolts of the same design, type and length as those you removed. **Do not use a substitute.**

Lubricate side cover bolts and torque bolts to **180-220 ft•lb** (244-298 N•m).

24. Remove tape from the sector shaft (41).

25. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Exxon Polyrex EP2. (P/N 045422). Apply more of the grease to the inside of a new dirt and water seal (2, 2B or 2C) and install it over the input shaft. Seat the seal in the groove behind the serrations and against the valve housing.

This step may have already been completed if you disassembled the valve housing and worm screw for repair.

Proceed to Final Adjustments on page 62



Poppet Component Replacement

Tools Required

2 lb Sledge
ft•lb Torque
wrench
J36452-A
Press
3/8" x 6" drill rod

Ratchet
Soft-jawed vise

Materials Required

Locquic "T" primer
Loctite RC680



Place rack piston in vise

Soft-jawed vise



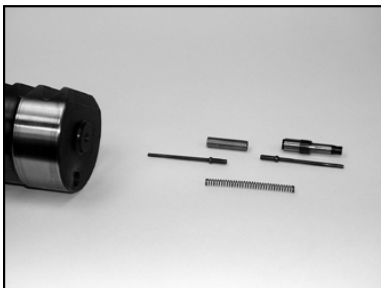
Loosen poppet adjuster seat

J36452-A
2 Lb Sledge



Remove poppet adjuster seat

J36452-A



Remove poppet components

1. If the poppet assemblies are to be removed for replacement, place rack piston in a soft-jawed vise.

2. Slide special tool #J36452-A over the seat of poppet adjuster seat and sleeve assembly (27) and engage tool in the slots in the threaded sleeve. Hit the end of the tool firmly four or five times with a 2 lb sledge hammer to loosen Loctite.

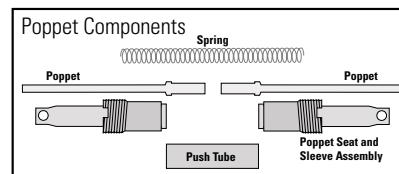


CAUTION

Poppet adjuster seat and sleeve assemblies (27) are retained by Loctite applied to the threads which makes the assemblies difficult to remove.

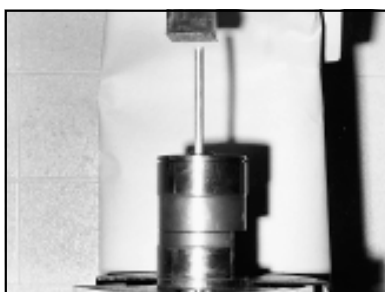
3. With a ratchet applied to the tool, turn one adjuster seat and sleeve assembly out of the rack piston. If the ratchet does not turn easily, strike the adjuster removal tool again with a hammer. If the engaging tangs won't stay in place while torquing, it might be necessary to hold in place with an arbor press while applying loosening torque. Discard poppet seat and sleeve assembly.

4. Remove the two poppets (26), spring (25), and push tube (24).





Remove other seat & sleeve if necessary



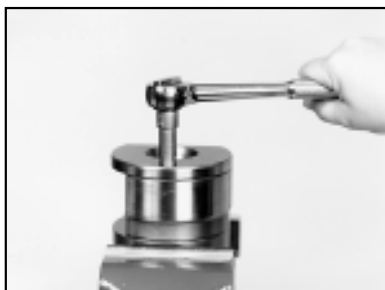
Reset remaining poppet seat and sleeve assembly

Press
3/8" X 6" Drill rod



Apply Locquic "T" primer and Loctite RC680

Locquic "T"
primer
Loctite RC680



Install one poppet seat and sleeve assembly

Soft-jawed vise



Install remaining poppet components

J36452-A
ft•lb Torque
wrench

5. Remove and discard remaining poppet seat and sleeve assembly only if required.

NOTE

It is possible to reset one poppet adjuster seat and sleeve assembly for automatic poppet adjustment while it is in the rack piston if one adjuster seat and sleeve assembly and the poppets, spring, spacer rod and push tube are removed.

6. If one poppet seat and sleeve assy. (27) was left in rack piston, it can be reset for automatic poppet adjustment by inserting a 3/8" (9.52 mm) diameter X 6" (152.4 mm) drill rod down through the poppet seat hole at the opposite end of the rack piston and against the adjuster seat to press the seat in until it bottoms against the adjuster sleeve.

7. Carefully apply Locquic "T" primer to the threads in poppet holes, and threads on the new seat and sleeve assemblies (27). Allow to dry for ten minutes; then carefully apply Loctite® RC680 to same threads.



CAUTION

Do not allow Loctite or Locquic to get on the adjuster seat component of the adjuster seat and sleeve assembly. The poppets will not function properly.



WARNING

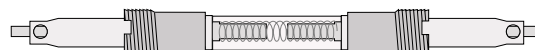
Wear eye protection while assembling poppets, as spring loaded poppets could eject and cause eye injury.

- 8.

Place rack piston (28) in a soft-jawed vise and turn one new poppet adjuster seat and sleeve assembly (27), (slotted end out) into the poppet hole in one end of rack piston.

9. From the other end of the poppet hole in the rack piston, install: one poppet (26), poppet spring (25), push tube (24), other poppet (26), and the other new poppet adjuster seat and sleeve assembly (27). The new components will stack up as shown below.

Torque both poppet seat and sleeve assemblies to **18 ft•lb (25 N•m)**.



Return to step 25, page 40.



Valve Housing/Worm Screw Disassembly

Tools Required		Materials Required
Hammer	in•lb. Torque wrench	Small probe or pick
ft•lb Torque wrench	J37464	Sockets
Punch, center	J37070	12-point sockets
Punch, roll pin	J37073	
	Screwdriver	



Place valve housing and valve assembly in vise

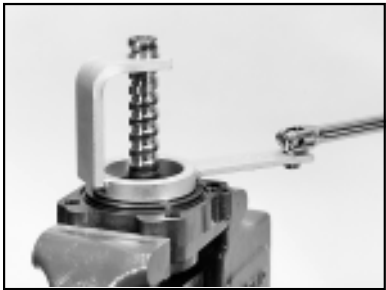
1. With worm vertical, place the valve housing (5), input shaft valve/worm assembly (15) in a vise.



Unstake adjuster locknut

Roll pin punch
Hammer

2. Unstake the valve housing (5) where it was upset into the adjuster locknut (21) slot. Also unstake adjuster nut from adjuster (20).



Remove bearing adjuster locknut

J37464

3. Turn bearing adjuster locknut (21) out of the valve housing.



Remove bearing adjuster

J37070

4. Turn bearing adjuster (20) out of the valve housing.



Remove seal ring and o-ring

Small probe or pick

5. Remove and discard seal ring (18) and o-ring (19) from bearing adjuster.



Remove input shaft

6. Remove the input shaft valve/worm assembly (15) from the valve housing (5).



Remove thin washer and bearing

7. Remove thin thrust washer (17) and thrust bearing (16) from input shaft (15).



CAUTION

Input shaft, valve worm assembly must not be disassembled further. The components were a select fit at assembly and are available only as part of this subassembly. If disassembled further, the subassembly must be replaced.



Remove ball bearing

8. Remove bearing (12) from valve housing.



WARNING

Do not remove the ball cup that the bearing (12) rides on. Do not remove the special spacer seal behind the ball cup.



Remove seal ring

Small probe or pick

9. Remove and discard seal ring (14) from valve housing (5).



Remove retaining ring

Screwdriver

10. Turn over valve housing and remove retaining ring (3).



Remove seal

1 1/8" Socket Hammer

11. **CAUTION** Exercise special care when removing seal (4) to prevent damaging the valve housing seal bore.

Tap input shaft seal (4) out of valve housing. Discard seal.

NOTE The valve housing also utilizes a ball plug for manufacturing purposes that must not be removed.



Inspect input shaft, valve worm assembly sealing areas

12. Inspect the sealing areas of input shaft and valve (15) for nicks and run your fingernail edge across the sealing surfaces to detect steps. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, you must replace the input shaft valve/worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.



Inspect thrust washer and bearings

13. Inspect the thrust bearing (16) rollers and ball bearing (12) for any deterioration. Inspect thrust washer (17) and ball bearing race in the valve housing for brinelling, spalling, or cracks. Replace any part with these conditions.



Place valve housing in vise

14. Place valve housing (5) firmly in a vise so the input shaft, valve/worm assembly (15) can be assembled vertically with the worm end up.

CAUTION Do not clamp against threaded port hole or relief valve hole sealing faces when placing valve housing in vise.



Assemble seal ring

15. Lightly oil and assemble new seal ring (14) into the large diameter seal ring groove in valve housing, bending and working it in and smoothing it out as necessary.

NOTE

The seal ring must be smoothed out or it may be damaged when the worm is installed.

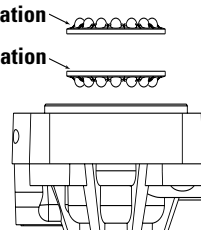


Install ball bearing into valve housing

16. Install ball bearing (12) into valve housing (5).

Incorrect installation

Correct installation



Assemble input shaft, valve worm.

17. Dip the input end of the input shaft, valve, worm assembly (15) into oil up to the worm lead. Assemble the input shaft end of the assembly into the valve housing (5) until it is firmly seated.



Assemble bearing and thrust washer

18. Apply oil and assemble the other thrust bearing (16) then the thin thrust washer (17) over the ball groove end of worm, and seat them against the shoulder of input shaft valve worm assembly (15).



Assemble seals in bearing adjuster

19. Lightly oil a new o-ring (19) and assemble into the seal groove in bearing adjuster (20). Oil and work a new seal ring (18) into the same groove and smooth it out.

NOTE

Be sure the valve housing, adjuster locknut and bearing adjuster threads are clean and free of any staking burrs that would impede the locknut from turning freely on adjuster or the adjuster turning freely in valve housing.



Assemble bearing adjuster

J37070
ft•lb Torque
wrench



Assemble new locknut

J37464



Adjust to required input torque

$\frac{3}{4}$ " or $\frac{11}{16}$ " 12-
point socket
in•lb Torque
wrench



Torque locknut

J37070
J37464
ft•lb Torque
wrench



Check input shaft torque

20. Lightly oil and assemble bearing adjuster (20) over worm and into valve housing. Torque adjuster to **13 ft•lb** (18 N•m) indicated torque using a torque wrench inserted in adjuster tool #J37070. This will seat the components. Back off adjuster $\frac{1}{4}$ to $\frac{1}{2}$ of a turn.

21. Lightly oil and assemble new locknut (21) onto bearing adjuster (20) with radius (slightly rounded) side down. Tighten slightly to keep the bearing adjuster in place.

22. Reverse assembly in vise so the worm end is down. With an inch pound torque wrench on the input shaft, note torque required to rotate the input shaft 360° in each direction. Tighten the bearing adjuster to increase the maximum torque at the input shaft **5-10 in•lb** (.5-1.0 N•m) over that which was previously noted.

23. Again reverse the assembly in vise. Torque locknut while holding bearing adjuster in position established in step 22 with appropriate adjuster tool. When using a torque wrench in locknut tool J37464, the torque wrench reading should be **112 ft•lb** (152 N•m).

24. Recheck input shaft torque. It should match torque measured in step 22. Repeat steps 22 and 23 if necessary.



Stake valve housing and locknut

Center punch
Hammer
1 $\frac{3}{16}$ " Socket
in•lb Torque
wrench



Reposition subassembly in vise



Install input shaft seal

J37073
Hammer

25. Stake valve housing into the clockwise most corner of two opposing slots in lock nut (21). Stake the locknut into the adjuster (20) in two places (180° apart) at threaded area. Choose areas that have not been previously staked.

After staking, torque required to rotate input shaft must be between **5-10 in•lb** (.5-1.0 N•m) **greater** than the torque noted in step 22. Torque value must **not exceed 22 in•lb** (2.5 N•m). Unstake and readjust if necessary.

26. Reposition worm screw/valve housing subassembly in soft-jawed vise, clamping tightly against valve housing, so the worm screw is pointing down.

27. Apply clean grease (Exxon Polyrex EP2, P/N 045422) to the outside and inside diameters (fill cavity between the lips) of the new input shaft seal (4) and assemble it, garter spring side first over the input shaft. Align seal in the valve housing seal bore.

Place seal installer tool #J37073, small diameter end first, over the input shaft and against the seal. Tap the seal installer tool until the tool shoulder is squarely against the valve housing. This will correctly position the seal in the housing bore just beyond the retaining ring groove.

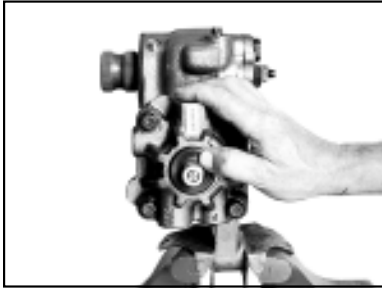
CAUTION Remove any seal material that may have sheared off and is in seal bore and retaining ring groove.

CAUTION The input shaft seal must be square in the seal bore and installed to the correct depth.



Insert retaining ring

28. Insert new retaining ring (3) into its groove in valve housing (5).

**Install dirt & water seal**

Grease

29. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Exxon Polyrex EP2 (P/N 045422). Apply more of the grease to the inside of a new dirt and water seal (2, 2B or 2C) and install it over the input shaft. Seat the seal in the groove behind the serrations and against the valve housing.

Return to step 26, page 40.

Roller Bearing Replacement

Tools Required

Press
J37705 (THP/PCF45)
J37071-A (THP/PCF60)

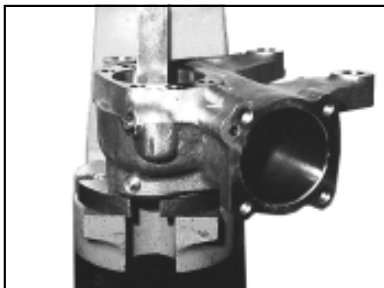
Materials Required



Remove roller bearing if required

J37705
THP/PCF45
J37071-A
THP/PCF60
Press

1. If roller bearing (39) in housing needs to be replaced, place the bearing removal end (long end) of the bearing and seal tool against the trunnion end of the bearing and press it out of the side cover end of the bearing bore. Discard bearing.



Press in housing roller bearing

J37705
THP/PCF45
J37071-A
THP/PCF60
Press

2. Press the new roller bearing (39) into the housing from the side cover end of the bearing bore until it is seated against the step bore. Be sure the housing is square with the press base and the bearing is not cocked.



CAUTION Use the bearing installation end of the tool (short end). If the bearing removal end of the bearing & seal tool is used to press in bearing, the cage on the new bearing may be damaged.

NOTE

If the unmachined trunnion face is not square, use shims to square it before pressing in the bearing.

Return to step 29, page 40.

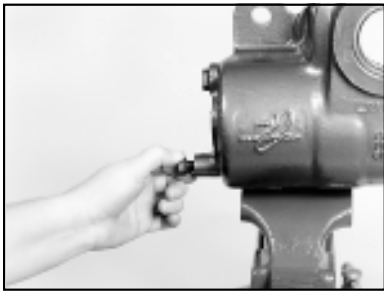


Replace Housing Port Plugs, Screws, and Fittings

Tools Required

Allen wrench
Torx sockets
SAE/Metric sockets
Open end wrench
in•lb Torque wrench
ft•lb Torque wrench

Materials Required



Replace poppet fixed stop screw

THP/PCF45
18mm Socket
THP/PCF60
5/8" Socket
ft•lb Torque wrench

1. If damaged, remove and replace the poppet fixed stop screw (38) and washer (Not shown) if equipped. Replace with poppet fixed stop screw (38), discard the washer. Torque to **48 ft•lb** (65 N•m).

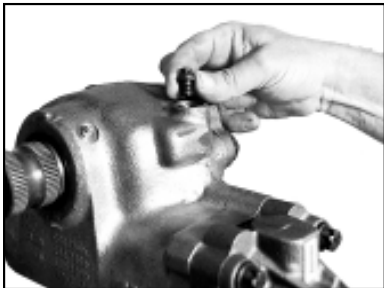


Replace poppet adjusting screw

THP/PCF45
6mm Allen wrench
18mm Socket
19mm Wrench
THP/PCF60
7/32" Allen wrench
5/8" Socket
3/4" Wrench
ft•lb Torque wrench

2. If damaged, remove poppet adjusting screw (38A) and sealing nut (38B) without allowing the nut to change its position on the screw.

Assemble the new nut onto the new adjusting screw, matching its position to the nut and screw removed. Torque sealing nut to **35 ft•lb** (47 N•m).



Replace automatic bleed screw, and aux. port plugs

E-14 Torx socket
ft•lb Torque wrench

3. If damaged, remove and replace automatic bleed plug (38). Torque to **48 ft•lb** (65 N•m).

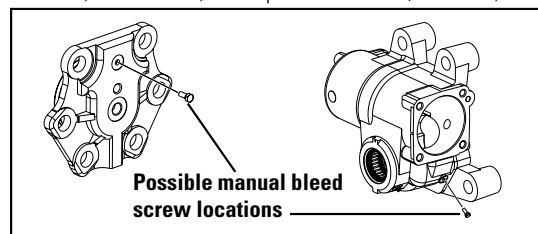
If damaged, remove and replace permanent auxiliary port plugs (7) and o-rings (6). Assemble new o-rings on port plugs and torque to their respective ports in the housing or valve housing to **30 ft•lb** (41 N•m).



Replace manual bleed screw

5/16" Hex socket
in•lb Torque wrench

4. If damaged, remove and replace manual bleed screw (Not shown). Torque to **45 in•lb** (3.4 N•m).



Return to inspection section, page 42.

Final Adjustments

Tools Required

Box-end
wrench
ft•lb Torque
wrench
in•lb. Torque
wrench

Screwdriver
Sockets

Materials Required



Center steering gear

$\frac{3}{4}$ " and $\frac{1}{16}$ "
Socket or box
end wrench

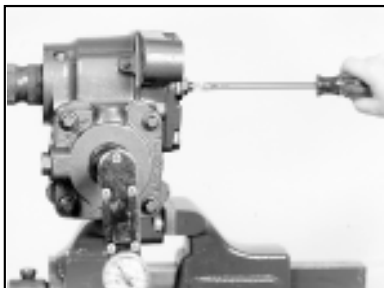
1. To center the steering gear, rotate input shaft valve worm assembly (15) until the timing mark on the end of the sector shaft (41) is in line with the timing mark on the end of housing trunnion.

CAUTION Do not rotate the input shaft more than 1.5 revolutions from center position until the steering gear is installed, during poppet setting procedure. Doing so could make the automatic poppets inoperative, which would require disassembly of steering gear to reposition poppet seat and sleeve assemblies.

NOTE Initial poppet contact will occur at less than one input shaft rotation in one direction from steering gear center position, if new or reset poppet adjuster seat and sleeve assemblies are assembled in the unit.

NOTE Worm preload adjustment was set when input shaft, valve and worm were assembled into valve housing.

Tighten adjusting screw

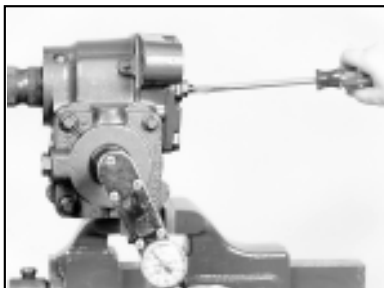


in•lb Torque
wrench
Screwdriver
 $\frac{1}{16}$ " or $\frac{3}{4}$ "
Socket

2. With adjusting screw jam nut (46) loose, turn sector shaft adjusting screw (41A) clockwise to provide **45-50 in•lb** (5-5.5 N•m) of torque required to rotate the input shaft valve/worm assembly (15) through one half turn (180°) each side of center.

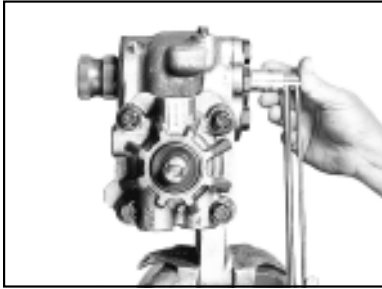
NOTE This procedure will properly mesh and seat the rack piston and sector shaft teeth for final adjustments.

Loosen adjusting screw and note torque



in•lb Torque
wrench
Screwdriver
 $\frac{1}{16}$ " Socket

3. Turn sector shaft adjusting screw (41A) counter-clockwise one half turn and **note maximum torque** required to rotate the input shaft, valve/worm assembly through one half turn (180°) each side of center.

**Adjust adjusting screw**

$\frac{3}{4}$ " Socket
 $\frac{11}{16}$ " Socket
ft•lb Torque wrench
in•lb Torque wrench

4. Adjust sector shaft adjusting screw (41A) clockwise **to increase** maximum torque noted in step 3 by **7 in•lb** (.8 N•m). Tighten jam nut (47) firmly against side cover while holding the adjusting screw in position. Finally, torque jam nut to **43 ft•lb** (58 N•m) and check input shaft valve/worm assembly torque again. Readjust if input shaft torque exceeds **40 in•lb** (4.5 N•m).

Section 5 Reinstallation

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Reinstallation

- Verify that axle stops are set to manufacturer's wheelcut or clearance specifications.
- Bolt gear to frame, torque to vehicle manufacturer's recommendation.
- Connect return line to reservoir in THP/PCF return port.
- Connect hydraulic line from pump to pressure port in THP/PCF unit.
- Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
- Install pitman arm on output shaft, with timing marks aligned. Torque bolt to vehicle manufacturer's recommendation.
- Connect drag link to pitman arm.

Poppet Resetting

IF Poppets remain unchanged from when gear was removed from vehicle, and gear is being installed on the same vehicle with no change in axle stops or linkage.



After installation, check to make sure poppets relieve in both turns just before axle stop contact is made. If not, use resetting procedure beginning on page 23.

IF Poppets were replaced with new components or reset during gear disassembly, and are ready for automatic positioning.



Use poppet setting procedure on page 13.

IF Poppets may have been moved during disassembly or reassembly procedures, or gear is being installed on a different vehicle.



Use poppet resetting procedure beginning on page 23.

Glossary

Aerated Fluid

Fluid with air bubbles

Automatic Bleed Systems

Gears are mounted in such a way that trapped air can be forced out of the system "automatically" without loosening bleed screw.

Axial

In-out movement along an axis (imaginary straight line on which an object moves)

Brinelling

Dents

Date Code

Date the steering gear was built (Julian date)

Discoloration

Change in color

External Leakage

Fluid Leaking out of the system or steering gear

Full Turn

Hub contacts axle stop

Integral Power Steering

Steering gear has manual steering mechanism, hydraulic control valve, and hydraulic power cylinder all within gear housing.

Impact

The application of torques and forces to steering gear components during accidents or other similar events which exceed the hydraulic capacity of the steering gear

Internal Leakage

Fluid leaking inside the gear

Lash

Free play

Manual Bleed Systems

Gears are mounted in such a way that an air pocket could form in one end of the steering gear. The bleed screw is positioned so trapped air can be forced out when loosened.

OSHA

Occupational Safety and Health Administration

PCF

Positive Center Feel - option available on THP series steering gears.

Poppets

Unloading valves, reduce pressure in full turns.

Relief Valve

Limits maximum supply pressure

Return Line

Line that connects steering gear to reservoir to recirculate hydraulic fluid

Rotary Control Valve

Controls flow in internal cavities

Scoring

Scratch

Shock Load

Shake or jar

Spalling

Flaking or chipping

Subassembly

An assembled unit that fits into a larger unit

Supply Line

Line that connects pump to steering gear

Twisted Serrations

Output shaft serrations damaged by impact overload. Serrations can be twisted at the area between the large diameter of the shaft and the end of the serrations.

**TRW****TRW Automotive**

Commercial Steering Systems

Steering Diagnostics Service Manual

CHART YOUR WAY TO EASY STEERING



845



⚠ WARNING A warning describes hazards or unsafe practices which could result in severe personal injury or death.

⚠ CAUTION A caution describes hazards or unsafe practices which could result in personal injury or product or property damage.

NOTE A note gives key information to make following a procedure easier or quicker.

Notice

This guide was prepared for the purpose of providing general advice concerning the diagnosis and correction of commercial vehicle steering related problems. This guide is intended for the use of properly trained, professional mechanics, NOT "Do-it-Yourselfers". Also, this guide should be used in conjunction with service manuals provided by both the vehicle and component manufacturers. Diagnosis and correction of commercial vehicle steering related problems should only be handled by properly trained, professional mechanics who have the proper equipment, tools, instructions and know-how to perform the work properly and safely.

Power Steering System Analyzer (PSSA) Gauge

Some of the tests in this manual require the use of a PSSA. This device is a combination flow meter, shut-off valve, and pressure gauge. This tool will allow you to measure flow and pressure, and provide a load on the pump through the hydraulic lines of the steering system. This tool is required to correctly analyze a steering system. TRW recommends that you **DO NOT BEGIN TROUBLESHOOTING A STEERING SYSTEM WITHOUT THE USE OF A PSSA**. If you are not sure how to use a PSSA, you may refer to the video available through our website at: www.trucksteering.com. This video compliments the tests in this book which require the use of the PSSA.

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⚠ WARNING

Throughout this troubleshooting guide, test procedures are recommended to help locate the cause of each complaint. While performing these tests, TRW advises that you **TAKE NECESSARY PRECAUTIONS** when working with internal vehicle components and hot hydraulic fluids.

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 Reduced Wheelcut

 Steering Wheel Kick

 Binding, Darting, and Oversteer

 Directional Pull

 Road Wander/Loose Steering

 Non-Recovery

 Shimmy

 Noise

 External Leakage

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Introduction

Understanding the Complaint

Steering systems for heavy duty trucks are made up of many components from the steering wheel to the road wheel. The purpose of the steering system is to give the driver directional control of the vehicle.

When a driver feels the steering control over his/her vehicle is not like it should be, it is up to you to determine if there is a problem, and if so, figure out what is causing it. It is always easier to fix something if you really understand the complaint. Some ways you could do this are:

- Talk to the driver and ask a lot of questions like “what, when, where, and how”
- Make sure you can feel or see the problem. Have the driver show you exactly what he/she means.
- Walk around the truck, looking for anything that may be an obvious cause of the problem.

To make your job easier and faster this manual has both the flow charts and test procedures/comments, each in their own section. Once you have a good understanding of what the complaint is, choose the flow chart that best matches the symptoms described to you. Because there are different ways to say the same thing, we have provided our definitions of the 10 most common complaints in this book. Use these to determine which section of the manual would be helpful to begin diagnosing the steering system.

Reading the flow charts:

Start the chart at the **BEGIN** box. Follow the lines to the next box answer the question or perform the test to verify the cause of the complaint, then proceed to the next step. These boxes are arranged in order of likelihood of being the cause of the driver's complaint. **It is important to complete the tests, in order, and follow the flow of the chart.** Locate correct test number in the TEST PROCEDURES section, and follow the test procedure. When you are done with the test, note the results and correct the root cause. If condition still exists, keep going through the chart (if necessary, to correct the problem). The results of some tests will need to be recorded. Use the TEST RESULTS section to record these values.

If you identify a problem through a test procedure it is important that you retest the vehicle to make sure the condition has been corrected.

Warranty

If you have identified that a steering component on your vehicle needs to be replaced, this does not always mean it is warrantable. Please read your manufacturer's warranty carefully before submitting a steering component for warranty consideration.

Definitions

1. Hard Steering

Hard Steering is when steering effort at the steering wheel is more than 200 inch pounds (typically 18-22 lbs at the rim of the steering wheel). Steering is still possible, but there is not enough power assist.

Common phrases used:

- Won't turn
- Locks-up
- Shuts-down
- Turns hard
- Hangs-up
- No assist
- Won't turn unless moving

2. Reduced Wheelcut

Common phrases used:

- Too great of turning radius required
- Wheelcut restricted
- Not enough turns lock to lock

3. Steering Wheel Kick

Steering Wheel Kick is when the road wheels hit a bump that the steering wheel reacts to. The kick is usually dampened out quickly.

Common phrases used:

- Kickback
- Backlash
- Bump steer

4. Binding, Darting and Oversteer

Binding is a change or increase in steering wheel effort. Binding will usually not require the effort levels described in Hard Steering, unless it is severe. Darting and oversteer are words that mean the driver suddenly gets more turning than he/she wants.

5. Directional Pull

Common phrases used:

- Steering pulls to the right (or left)
- Truck pulls to the right (or left)
- A constant force is required to keep the truck going straight



Definitions

6. Road Wander/Loose Steering

Common phrases used:

- Lash in steering
- Lost motion in steering
- Continual corrections are needed at the steering wheel to keep the vehicle from wandering

7. Non-Recovery

Common phrases used:

- Wheels don't return to straight ahead

8. Shimmy

A severe Shimmy condition can be felt at the steering wheel. Typically once something triggers a Shimmy condition to occur it is sustained until the driver does something (such as slow down) to dampen out the condition.

Common phrases used:

- Shake at steering wheel

9. Noise

Common phrases used:

- Steering is noisy
- Clicking or clunking sound is heard when steering

10. External Leakage

Common phrases used:

- Loss of steering fluid
- Continual adding of fluid in reservoir required

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Section 2 Flow Chart Diagrams

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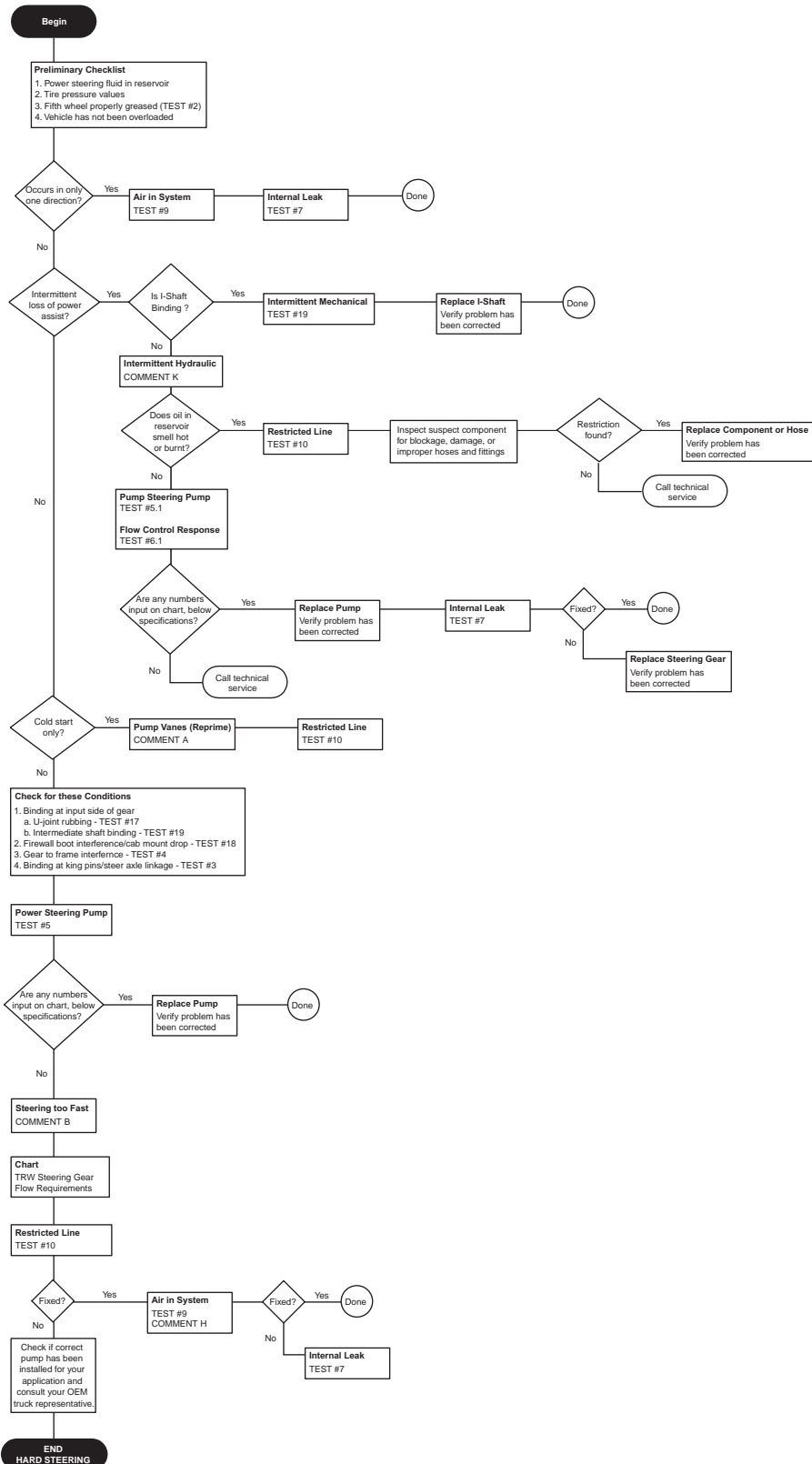
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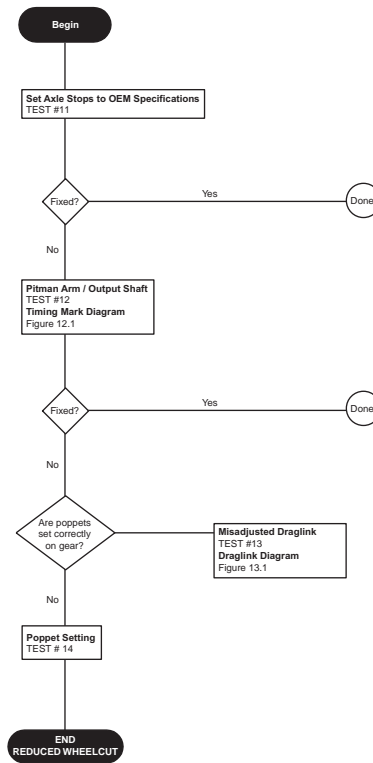
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Hard Steering

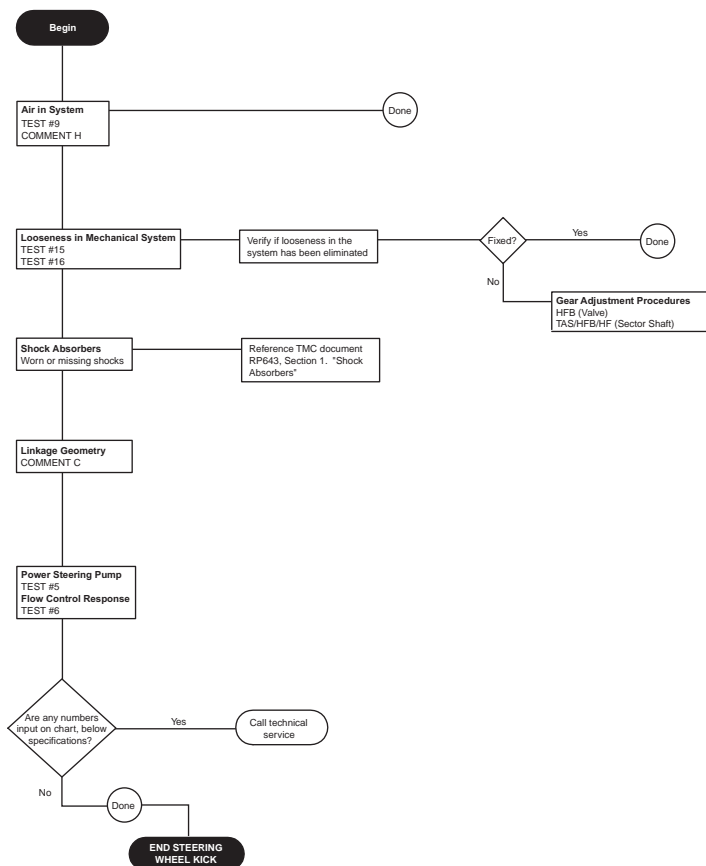




Reduced Wheelcut

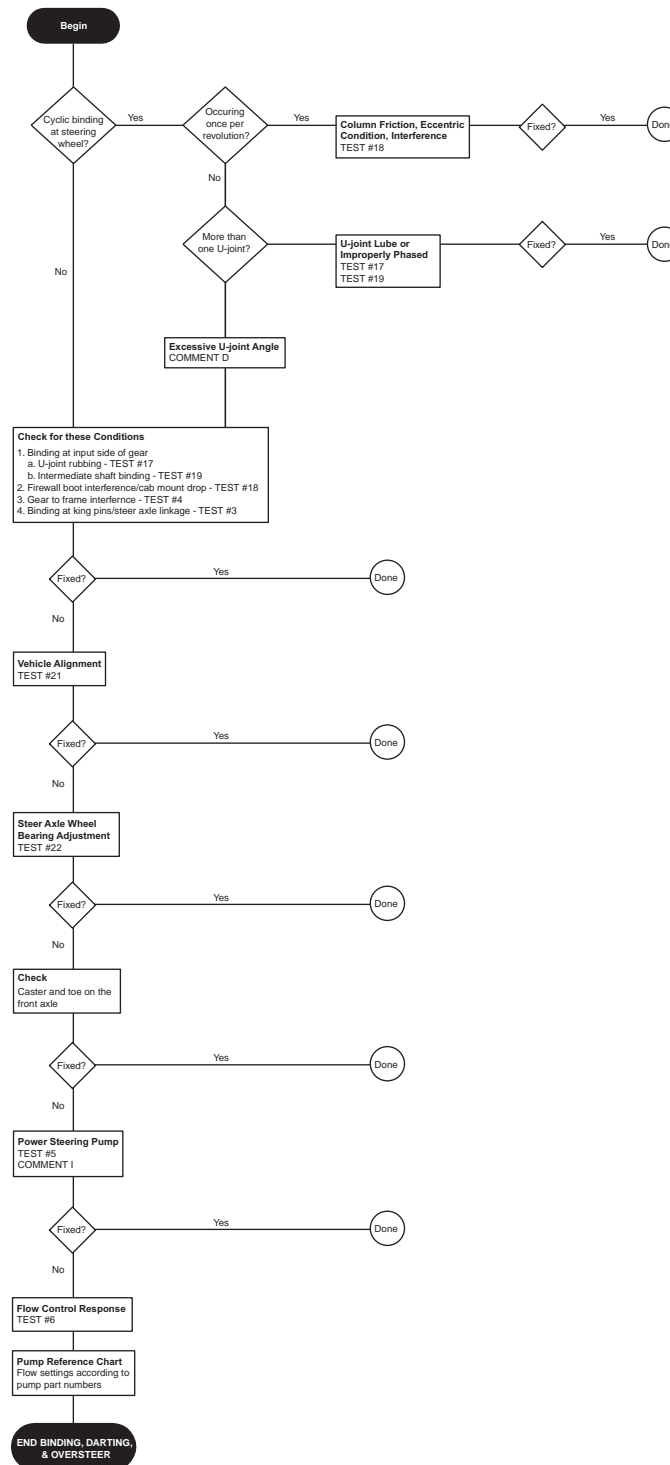


Steering Wheel Kick

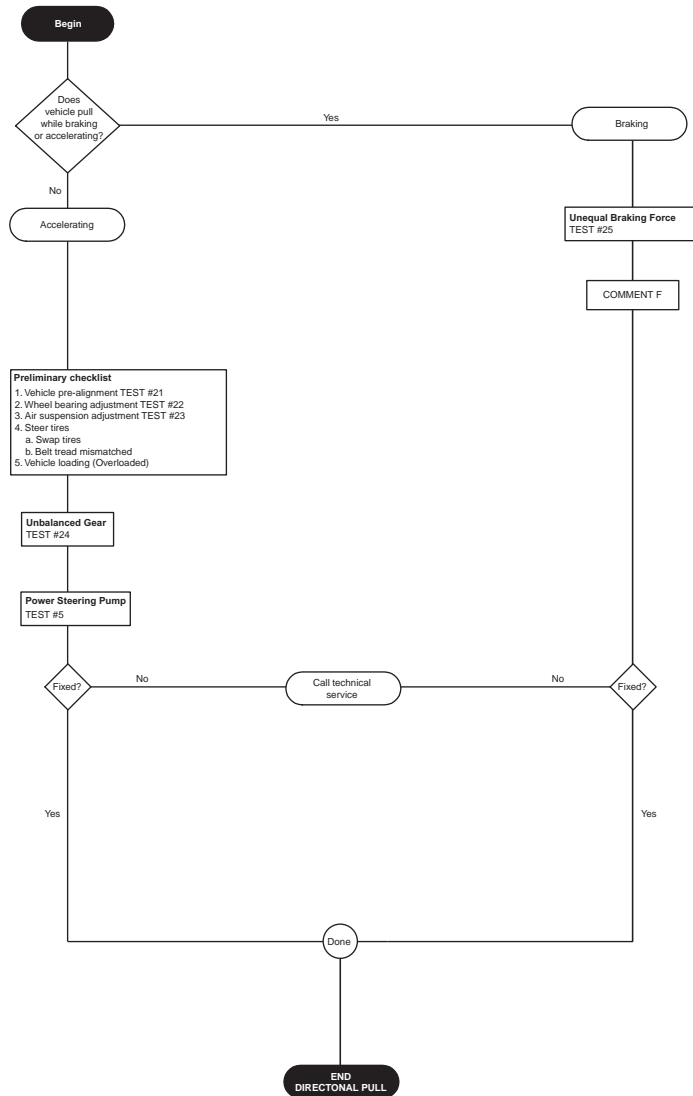




Binding, Darting, and Oversteer

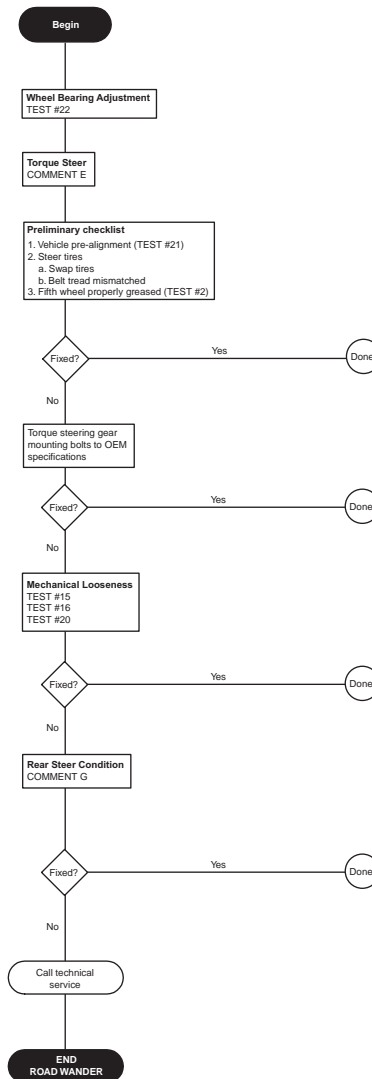


Directional Pull

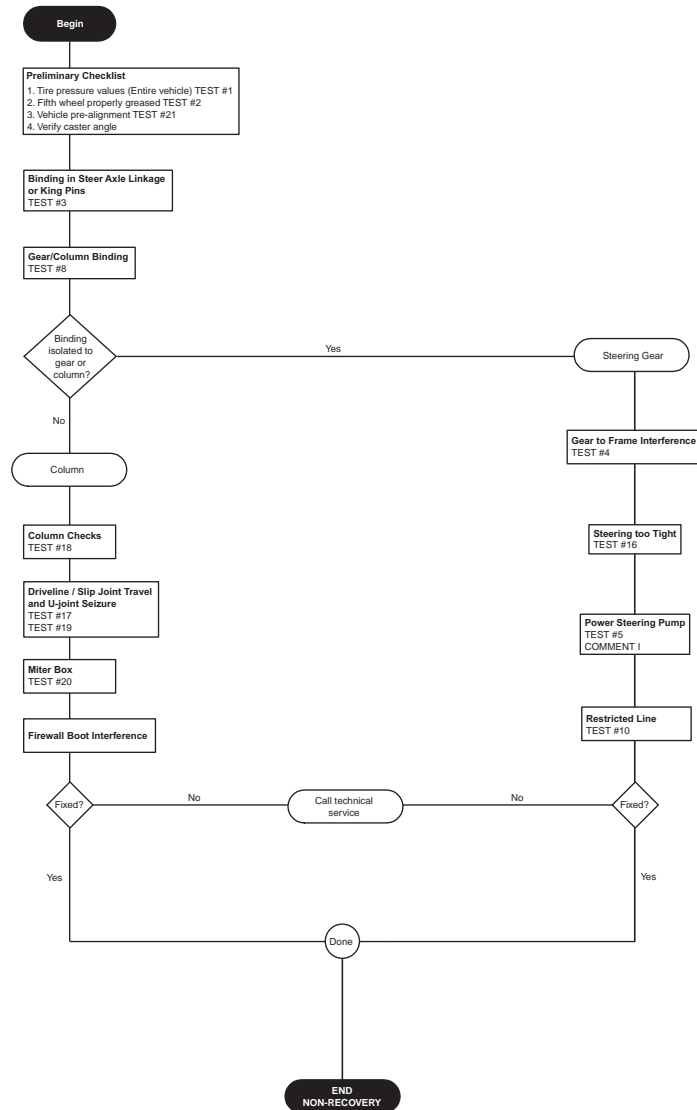




Road Wander/Loose Steering

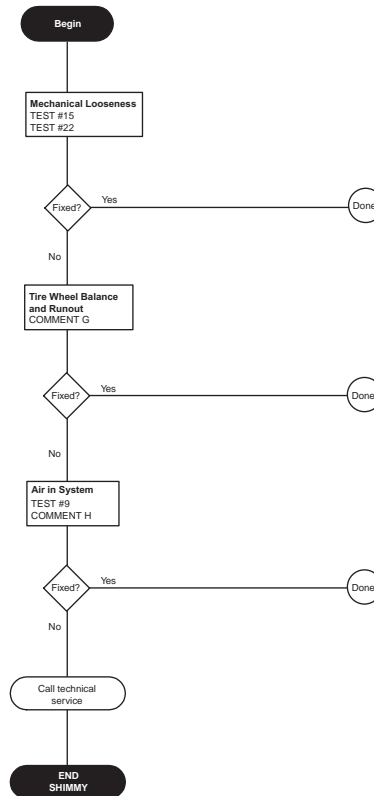


Non-Recovery

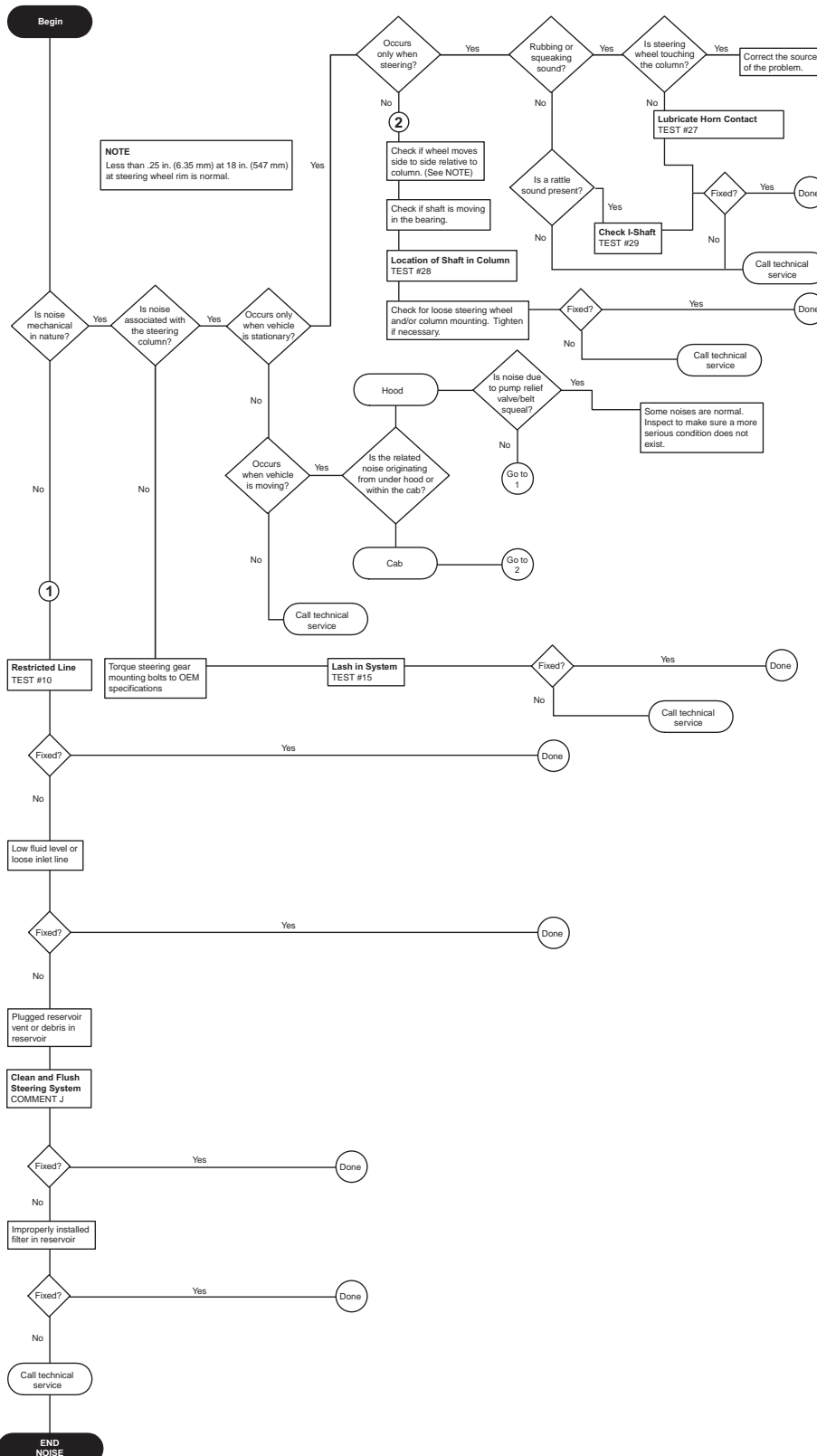




Shimmy

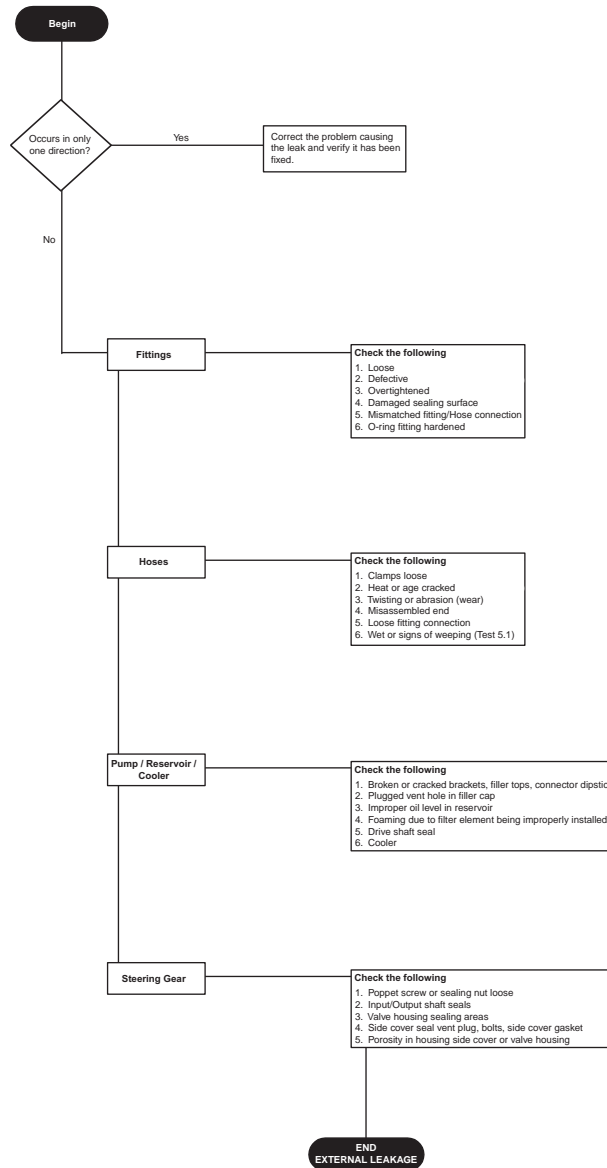


Noise





External Leakage



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Section 3 Test Procedures

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Test #1

Steer Tire Check

1. Look for: Tire damage, Uneven or extreme tread wear, mismatched tires or other wear indicators that would cause the problem. *Figure 1.1.*
2. Check tire pressures on steer axle tires. *Figure 1.2.*

Test #2

Fifth Wheel and Trailer Plate

1. Look for dry fifth-wheel or trailer plate. *Figure 2.1.*
2. Look for damage to fifth-wheel or trailer plate. *Figure 2.2.*
3. Inspect fifth-wheel for looseness.

Test #3

Steer Axle and Linkage Binding

1. With vehicle steer tires on radius plates (turntables) or equivalent, disconnect the drag link or pitman arm from the steering gear, (and linkage from assist cylinder if there is one on the vehicle). *Figure 3.1.*

⚠ CAUTION Do not steer the gear with linkage removed, as misadjustment of automatic poppets may result.

2. By hand, pull the tire to one axle stop and release (engine off). The tire should self-return to near straight ahead. *Figure 3.2.*
3. Repeat the test in the opposite direction.
4. If tire does not self-return to near straight ahead, a problem is likely in steer axle king pin bushings/bearings or linkage.

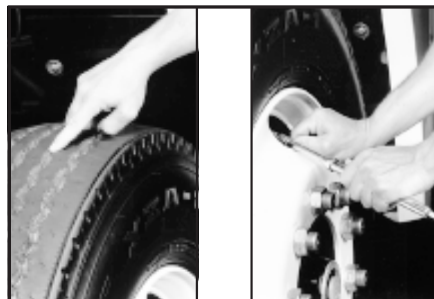


Figure 1.1

Figure 1.2

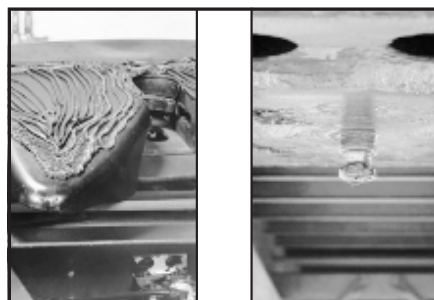


Figure 2.1

Figure 2.2



Figure 3.1



Figure 3.2

**Test #4****Steering Gear Mounting**

1. Look for anything between the steering gear and frame that could cause a binding problem. For example: hoses or brackets that have been routed, or are interfering between the steering gear and frame, frame flanges or spring mounting points. *Figure 4.1*. Mounting pads lower than steering gear housing, lack of clearance between frame and steering gear valve housing adapter, sector shaft adjusting screw and nut contact with access adjustment hole in frame. If interference is found, correct the problem.
2. If the steering gear has been mounted to the frame in a way that causes the gear to distort (not be flat), it may cause a steering problem. *Figure 4.2*. Checking to see if distortion is present on the vehicle may require the following test:
3. With vehicle parked and engine running, steer the wheel slowly checking for a binding-type of feel at the steering wheel. When binding is felt (stop engine loosen one mounting bolt restart engine) and steer the vehicle again. Continue to loosen one mounting bolt at a time, shutting off engine each time, and check for improvement in the binding condition. If improvement is made by loosening the bolts, determine by inspection the condition causing the gear to distort and correct the problem. Distortion of .030" (.80 mm) or less is acceptable. If greater than .030" (.80 mm) surface flatness, condition must be corrected.

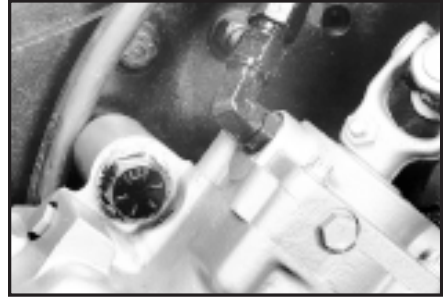


Figure 4.1

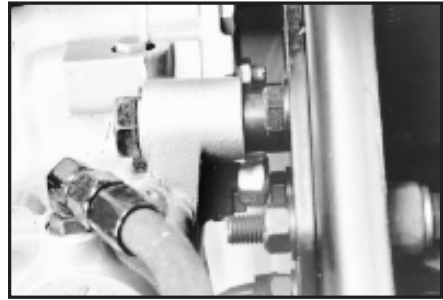


Figure 4.2

Test #5

Power Steering Pump Test

IMPORTANT: Read the following instructions below before completing **Table 5**, located in the "TEST RESULTS" section.

Verify Engine Idle speed per your OEM specifications.

1. Install temperature gauge in reservoir. *Figure 5.1.* Install PSSA in pressure line with shut-off valve fully open. *Figure 5.2.*
2. Run the engine at 1000 rpm.

CAUTION When closing the PSSA shut off valve, do so slowly and keep an eye on the pressure gauge. Do not allow the system to exceed 3000 psi (207 bar) for safety of personnel and to prevent damage to the vehicle.

CAUTION Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up.

3. Measure and record the following flow and pressure readings (see chart) by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. *Figures 5.3-5.7.*
4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed.
5. Determine the recommended flow range and maximum allowable system pressure for the steering system being used by referring to your service manual.
6. Compare the minimum and maximum flows (and the relief pressure you measured) to gear and pump specifications.
7. If the minimum measured pump flow is less than the minimum recommended flow for the steering gear used (see **Steering Gear Flow Requirements** chart), the pump may not be putting out enough flow for an adequate steering speed. If the maximum system pressure is lower than that specified for the pump (check your manual), it may not be developing enough pressure to steer. If either case exists, the pump needs to be repaired or replaced.

NOTE When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.



Figure 5.1

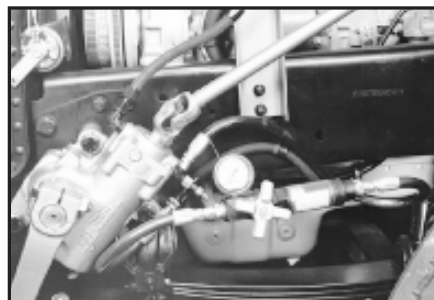


Figure 5.2

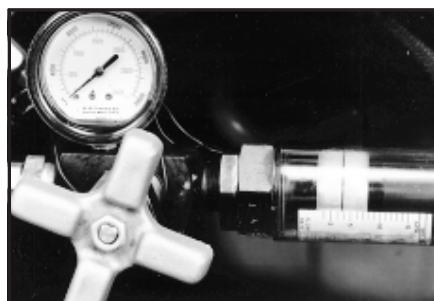


Figure 5.3

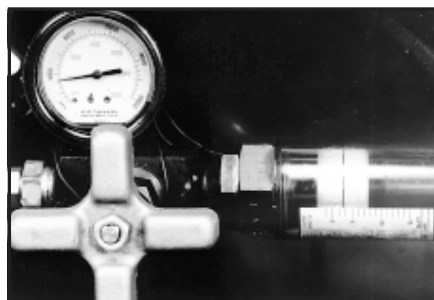


Figure 5.4

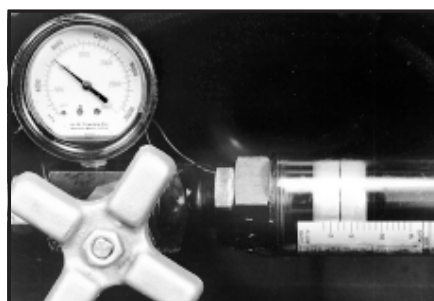


Figure 5.5



Test #5.1

40 Minute Power Steering Pump Test

IMPORTANT: Read the following instructions below before completing **Table 5.1** in the "Test Results" section.

Verify Engine Idle speed per your OEM specifications

1. Install temperature gauge in reservoir. *Figure 5.1*. Install PSSA in pressure line with shut-off valve fully open. *Figure 5.2*. Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30 and 40 minutes. Do not allow the temperature to exceed 250° F (121° C).

NOTE

If the temperature goes over 250° F (121° C) , or 150° F (66° C) above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

2. Run the engine at idle speed.



CAUTION

When closing the PSSA shut off valve, do so slowly and keep an eye on the pressure gage. Do not allow the system to exceed 3000 psi (207 BAR) for safety of personnel and to prevent damage to the vehicle.



CAUTION

Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up.

3. Measure and record the following flow and pressure readings (see chart) by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed. *Figures 5.3-5.7*.
4. Now with the load valve fully open, increase the engine speed to governed RPM and measure and record the following flow and pressure readings by adjusting the load valve while listening for any unusual noises as the valve is being opened and closed.
5. Determine the recommended flow range and maximum allowable system pressure for the steering system being used by referring to your service manual.
6. Compare the minimum and maximum flows, and the relief pressure you measured to gear and pump specifications.
7. If the minimum measured pump flow is less than the minimum recommended flow for the steering gear used (see **Steering Gear Flow Requirements** chart), the pump may not be putting out enough flow for an adequate steering speed. If the maximum

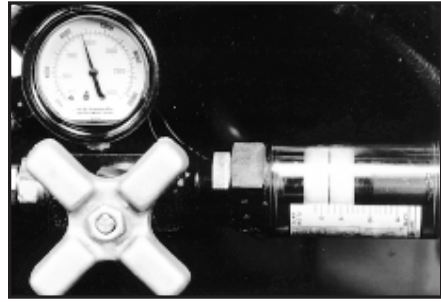


Figure 5.6

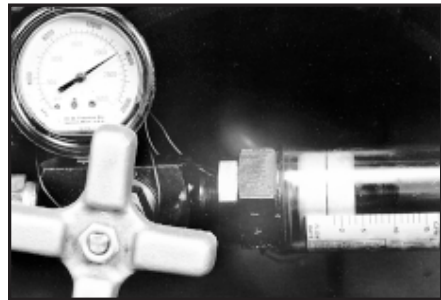


Figure 5.7

system pressure is lower than that specified for the pump (refer to your OEM service manual), it may not be developing enough pressure to steer. If either case exists, the pump needs to be repaired or replaced.

NOTE When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.

Test #6

Pump Flow Control Response

IMPORTANT: Read the following instructions below before completing **Table 6**, in the "Test Results" section

1. Install temperature gauge in reservoir. *Figure 6.1*. Install PSSA in pressure line with shut-off valve fully open. *Figure 6.2*.

NOTE If the temperature goes over 250° F (121° C) , or 150° F (66° C) above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

CAUTION Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up. (Do not allow the pressure to exceed 3000 psi (207 bar).

2. With the engine at idle, note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading you noted above.
3. With the load valve open run the engine to governed speed and note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading noted above.
4. Conduct this pump response test three times at idle and three times at 1500 RPM. If the flow rate does not return immediately, the pump is malfunctioning, which can result in momentary loss of power assist.

NOTE When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.



Figure 6.1



Figure 6.2



Test #6.1

40 Minute Pump Flow Control Response

Read the following instructions below before completing **Table 6.1** in the "Test Results" section

1. Install temperature gauge in reservoir. *Figure 6.1.* Install PSSA in pressure line with shut-off valve fully open. *Figure 6.2.* Park the vehicle outside. Record ambient temperature. Run the engine at governed RPM for 40 minutes to bring the fluid up to an elevated testing temperature. Measure and record the fluid temperature at the start and at 10, 20, 30, and 40 minutes. Do not allow the temperature to exceed 250° (121°C)

NOTE

If the temperature goes over 250° F (121° C) , or 150° F (66° C) above the surrounding temperature (ambient) at any time during the test, stop the test. This temperature level is considered extreme and steering system performance and life will be seriously affected. Damage to hoses, seals, and other components may result if operated at extreme temperature. If the steering system is operating above the recommended temperatures, the heat problem may be the root cause of the complaint.

CAUTION

Do not keep the load valve closed for more than 5 seconds at a time because damage to the system may result from excessive heat build-up. (Do not allow the pressure to exceed 3000 psi (207 bar).

2. With the engine at idle, note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading you noted above.
3. With the load valve open run the engine to governed speed and note the flow rate. Fully close the load valve until the flow drops to zero. Quickly open the load valve observing the flow meter. The flow rate must instantly return to the reading noted above.
4. Conduct this pump response test three times at idle and three times at 1500 RPM. If the flow rate does not return immediately, the pump is malfunctioning, which can result in momentary loss of power assist

NOTE

When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.

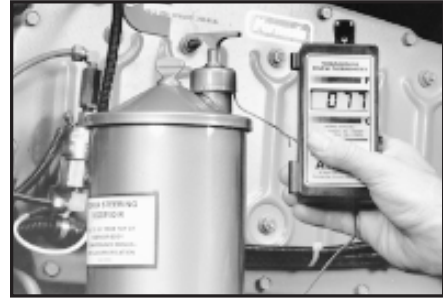


Figure 6.1

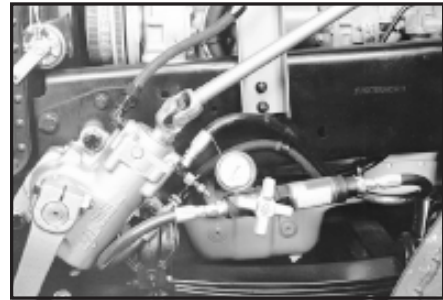


Figure 6.2

Test #7

Measured Internal Leakage

1. Install temperature gauge in reservoir. *Figure 7.1.* Install PSSA in pressure line with shut-off valve fully open. *Figure 7.2.*

⚠ WARNING THIS TEST CAN BE DANGEROUS IF NOT PERFORMED CORRECTLY. KEEP YOUR FINGERS CLEAR OF THE AXLE STOPS AND SPACER BLOCK DURING THIS TEST. MAKE SURE THAT THE SPACER BLOCK CONTACTS THE AXLE STOP SQUARELY. CONTACT THAT IS NOT SQUARE COULD BREAK THE AXLE STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.

2. To test the steering gear for internal leakage, you must first prevent operation of the gear's internal unloading (poppet) valves or relief valve (or both, in some gears). This will allow full pump relief pressure to develop. To prevent operation of the poppets, place an unhardened steel spacer block, about one inch thick and long enough to keep your fingers clear between the axle stop at one wheel. *Figures 7.3-7.4.* To prevent operation of the relief valve, remove the relief valve cap, o-ring and two piece relief valve, if equipped, from valve housing. Install the relief valve plug, special tool number J37130 in its place.

NOTE Be sure you reinstall the relief valve and valve cap with new o-ring, back onto the gear after leakage test.

⚠ CAUTION When running this test, do not hold the steering wheel in the full turn position for longer than 5 to 10 seconds at a time to avoid damaging the pump.

⚠ WARNING KEEP YOUR FINGERS CLEAR OF THE AXLE STOPS AND SPACER BLOCK DURING THIS TEST. MAKE SURE THAT THE SPACER BLOCK CONTACTS THE AXLE STOP SQUARELY. CONTACT THAT IS NOT SQUARE COULD BREAK THE AXLE STOPS OR DANGEROUSLY THROW OR EJECT THE SPACER BLOCK.

3. With the fluid temperature between 125-135° F (52-57° C), turn the steering wheel until the axle stop bolt contacts the spacer block.
4. Apply 20 pounds of force to the rim of the steering wheel during this test to be sure that the steering gear control valve is fully closed. *Figure 7.5.* The pressure gauge should now read pump relief pressure, as noted during the Flow Control Response Test (Test #6). You can now read steering gear internal leakage on the flow meter.
5. Repeat this test for the opposite direction of turn.
6. If internal leakage is greater than 1 gpm (3.8 lpm) and there is no auxiliary hydraulic linear or rotary cylinder in the system, repair or replace the gear. If the internal leakage is greater than 2 gpm (7.6 lpm), and there is an auxiliary hydraulic linear or rotary cylinder in the system, controlled by the gear, isolate the auxiliary cylinder from the system by disconnecting the auxiliary cylinder hydraulic



Figure 7.1

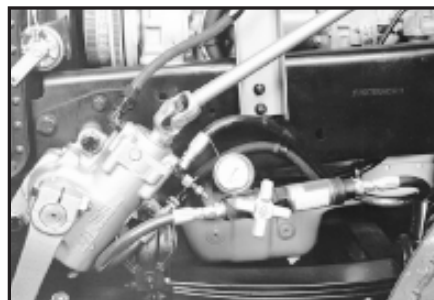


Figure 7.2



Figure 7.3



Figure 7.4



Figure 7.5



lines at the gear auxiliary ports. Plug the steering gear ports with suitable steel or high pressure plugs or caps.

In the event that a rotary cylinder is used in the system, connect the disconnected lines together with a suitable union fitting. In the case of a linear cylinder, first plug the disconnected lines and then disconnect the cylinder from the steering linkage, making sure it will clear the steered axle. *Figures 7.6-7.7.*

Repeat the internal leakage test. If the internal leakage is less than 1 gpm (3.8 lpm), repair or replace the auxiliary cylinder. If the internal leakage is greater than 1 gpm (3.8 lpm), repair or replace the gear.

NOTE When hydraulic tests are completed and fluid lines are reconnected, check fluid level and bleed the air from the hydraulic system.

Test #8 Steering Column Binding

1. With the vehicle parked, the engine off, and the steer axle jacked-up, slowly steer the vehicle until the binding position is located.
2. With the steering gear at this position, remove the steering column assembly from the steering gear. Note the correct position of the column and steering gear for reassembly after test. *Figure 8.1*
3. Rotate the steering gear input shaft no more than 1/4 turn each direction and check if binding is still present. *Figure 8.2* If binding is not felt, correct the steering column problem.

Test #9 Air in Hydraulic System

1. Inspect reservoir for foaming or air bubbles. *Figure 9.1* If foaming or bubbles are seen, air is being sucked into the system through cracks or loose fittings. Look for oil level changes engine off versus engine on, if fluid level increases when the vehicle is shut off, there is an air pocket trapped in the steering gear. The increase may not be noticeable, depending on the size of the pocket.
2. Bleed the steering gear (if there is a manual bleed screw at the top of the gear). With system at normal operating temperature and engine at proper idle speed and running, open the bleed screw and wait until clean, clear oil begins to flow from the gear. Close the bleed screw and steer the vehicle completely from stop to stop.
3. Repeat the bleeding operation three times, and recheck oil level in reservoir to make sure there is enough oil for the system to operate properly.



Figure 7.6

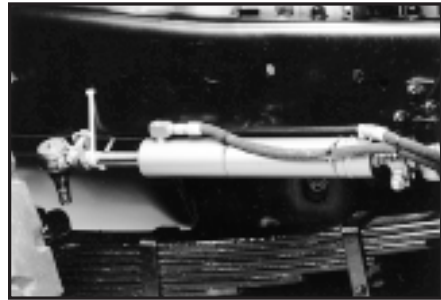


Figure 7.7



Figure 8.1



Figure 8.2



Figure 9.1

27

Test #10 Restricted Hydraulic Line

Read the following instructions below before completing **Table 10**, in the 'Test Results' section

1. Look at the supply line that goes to the pump to check for kinking or any other obstructions or irregularities on the inside of the hose. *Figure 10.1.*
2. Install PSSA with load valve fully open. *Figures 10.2-10.3.* Insert temperature gauge into reservoir. With oil between 125-135 °F (52-57 °C), determine a test engine speed (RPM) that causes pump to deliver 3, 4, 5 or 6 gpm (11, 15, 19, or 23 lpm) (which-ever is easier) and note this speed.
3. Remove the PSSA and install a low pressure gauge (200-300 psi (14-21 bar)) maximum with approximately 10 psi (.70 bar) per division) in the pressure line to the steering gear at the pump end. Install a temperature gauge in the power steering reservoir.

CAUTION Do not allow system pressure to exceed the rating of the gauge during the following procedure or damage to the gauge will result. Extremely high restrictions may be indicated with the PSSA gauge as installed with load valve fully open.

NOTE Be sure that the steering gear input shaft is not being restrained from recentering because this will cause a false steering gear pressure drop. If there is any question, conduct this test with the steering column removed.

4. Bring the power steering fluid temperature to 125-135 °F (52-57 °C), at engine idle, with no steering force applied to the steering wheel. *Figure 10.4.*
5. At the test engine speed selected from step 2 above, measure and record the gauge reading and shut off the engine. This measures total system pressure.
6. Remove the pressure and return lines from the steering gear and connect them together with a fitting that will not restrict the flow. *Figure 10.5.*
7. Start the engine, and run at the RPM identified in step 2 with the fluid temperature between 125-135 °F (52-57 °C).
8. Measure and record gauge reading and shut off engine. This is hydraulic line/reservoir pressure.
9. The difference between the total system pressure gauge reading and the hydraulic line/reservoir pressure gauge reading is the steering gear pressure drop. For a TRW steering gear, at a flow of 3, 4, 5 or 6 gpm (11, 15, 19, or 23 lpm), the drop should not be greater than 30, 40, 55 or 70 psi (2.0, 2.8, 3.8, 4.8 bar) respectively. The line/reservoir pressure drop for a flow of 3, 4, 5 or 6 gpm (11, 15, 19, or 23 lpm) should not be greater than 20, 20, 25 or 25 psi (1.4, 1.4, 1.7, 1.7 bar) respectively.



Figure 10.1



Figure 10.2



Figure 10.3



Figure 10.4

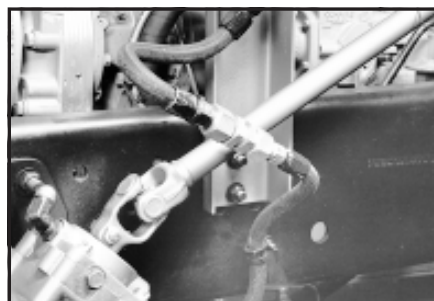


Figure 10.5

**Test #11**
Axle Stop Setting

Put vehicle steer tires on radius plates (turntables). Check to make sure axle stops are set to manufacturer's specifications. *Figure 11.1.*

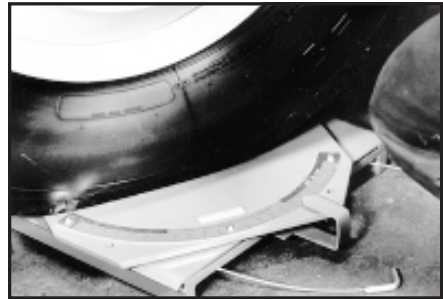


Figure 11.1

Test #12
Pitman Arm and Output Shaft Alignment

Look to make sure the output shaft timing mark is lined up with the pitman arm timing mark. Some pitman arms have more than one mark, so make sure the right one is used. *Figure 12.1.*

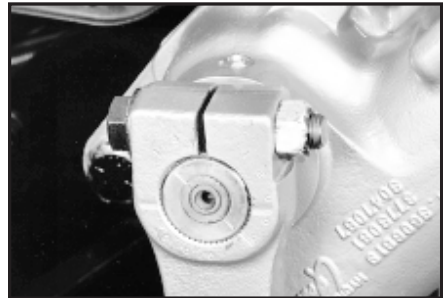


Figure 12.1

Test #13
Misadjusted Drag Link

The length of the drag link must be correct for the steering system. Check the length after you make sure the pitman arm/output shaft timing marks are aligned, the gear is at its center position, and the road wheels are straight ahead. *Figure 13.1.*

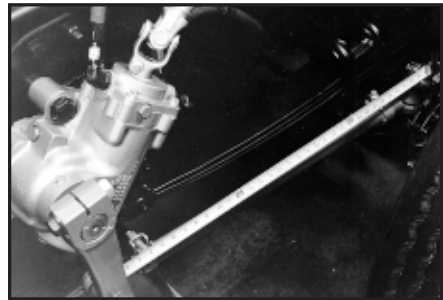


Figure 13.1

Test #14
Poppet Setting Procedure

1. If you are working on a newly-installed TAS steering gear, refer to the service manual to correctly set the poppets. If you are working on a steering gear, other than a TAS series, refer to the OEM's service manual for correct poppet setting instructions.
2. To set poppets on a TAS series gear using the adjustable service kit, refer to your steering gear service manual.

Test #15

Lash in Steering System

Two people are needed for this test. One person will slowly turn the steering wheel back and forth one-quarter turn each way from center with the engine idling. The other person should check for looseness at each of the following areas from steering wheel to road wheels: *Figures 15.1-15.5.*

- * Steering wheel to steering column
- * U-joints, or slip-joint and/or miter boxes
- * Steering column to steering gear input shaft
- * Steering gear input shaft to steering gear output shaft
- * Pitman arm to output shaft
- * Drag link to pitman arm connection
- * Drag link ends (sockets) and adjustable areas
- * Axle arm to drag link connection
- * King pin axle connections (bushings)
- * Tie rod arms to tie rod connection
- * Tie rod ends (sockets) and adjustable areas
- * Steering spindle
- * Wheel bearings
- * Lug nuts
- * Spring pin connectors
- * Front axle u-bolts
- * Spring hanger brackets/rear shackles

NOTE

Cracked or broken components can cause symptoms similar to loose components but may be more difficult to find.

NOTE

Be sure to check rear drive axles for any looseness and inspect tires for signs of abnormal wear.

Test #16

Steering Gear Adjustment

Check and adjust according to the appropriate service manual for your steering gear if necessary

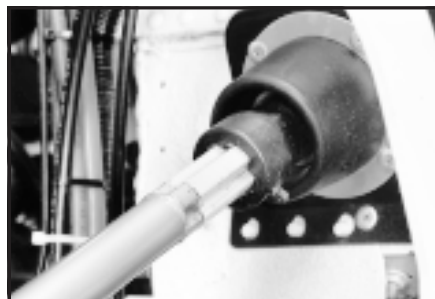


Figure 15.1



Figure 15.2



Figure 15.3



Figure 15.4



Figure 15.5

**Test #17****U-Joint Phasing and Lubrication**

1. Make sure u-joints are properly lubricated.
2. Steering column assemblies with more than one universal joint (cardan type) can cause a cyclic binding feel or torque variation at the steering wheel if the u-joints are not in phase with each other. *Figure 17.1-17.2.* If a steering column assembly with multiple u-joints is taken apart, it must be reinstalled with the timing marks for slip mechanisms aligned. This is true for both the cross-type and the splined-type two-piece intermediate shaft.

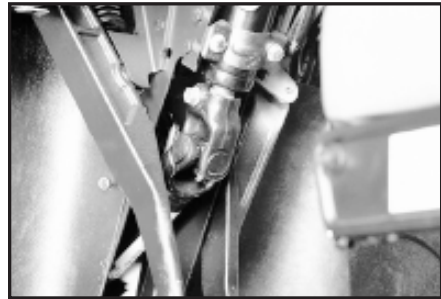


Figure 17.1

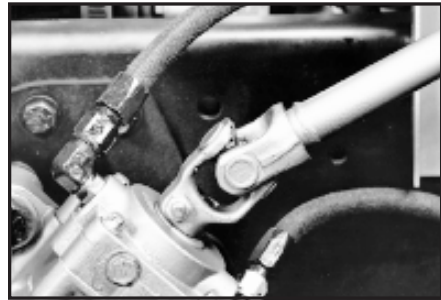


Figure 17.2

Test #18**Steering Column Interference**

Position steering wheel at the location where steering wheel interference is noticed, and look for something interfering or rubbing on the rotating column assembly such as brackets, bolts, floorboard, boot, etc.

Test #19**Intermediate Column Interference**

1. Check the slip column by looking to make sure there is proper travel allowance when in use. *Figure 19.1.*
2. Look for wear or galling. *Figure 19.2.*
3. Check slip column for too much slip force

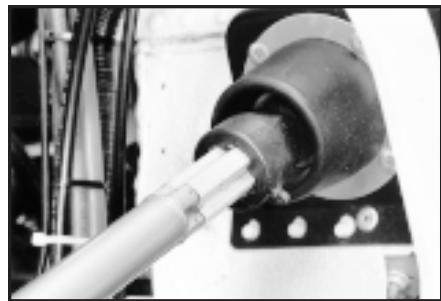


Figure 19.1



Figure 19.2

Test #20

Miter Box Misadjusted (if equipped)

Check and adjust per manufacturer's instructions. *Figure 20.1.*

Test #21

Vehicle Alignment

Check alignment of steered axle and rear drive axles, and trailer axles (if problem only exists with trailer). *Figure 21.1.*

Test #22

Wheel Bearing Adjustment

Verify that adjustment is made according to manufacturer's specification. *Figure 22.1.*

Test #23

Air Suspension Adjustment

Check and set to manufacturer's specifications

Test #24

Gear Imbalance

1. Install a low pressure gauge (200-300 psi (14-21 bar) maximum with approximately 10 psi (.70 bar) per division) in the pressure line from pump to gear. *Figure 24.1.*

CAUTION Do not allow system pressure to exceed the rating of the gauge in the following procedure or damage to the gauge will result.

2. At engine idle, slightly turn the steering wheel one direction until a pressure rise is observed at the gauge. *Figure 24.2.*
3. Stop steering and gently allow the steering wheel to recenter.
4. Next slightly turn the steering wheel the opposite direction while observing the gauge and determine if pressure initially rises or falls with initiation of a turn.
5. Repeat test a few times in each direction.
6. If a consistent fall in pressure is associated with the initiation of a turn in one direction, the steering gear's control valve is unbalanced and needs to be replaced.

Test #25

Unequal Brake Force

Visually inspect brake assemblies for oil/grease on braking surfaces, and overall condition of brake surfaces. Adjust or replace brakes if necessary.



Figure 20.1

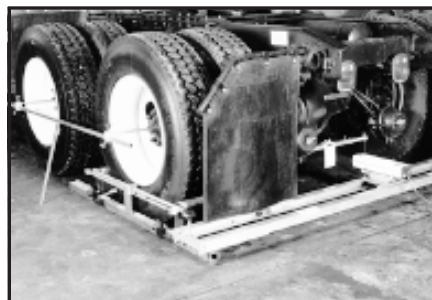


Figure 21.1



Figure 22.1

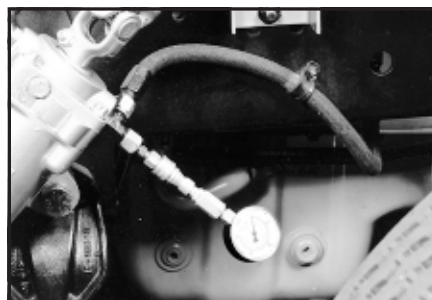


Figure 24.1



Figure 24.2

**Test #26****Tire Balance / Runout**

Have wheel assemblies balanced and checked for lateral and radial run out per manufacturer's specifications. Preferred method for checking balance is with wheels still on the vehicle. Balance includes total rotating assembly.

TEST #27**Steering Column Noise**

If column does not include a clockspring, remove steering wheel and add dielectric grease to the horn contact. The grease TRW uses is Model No. K-5/X Semifluid CA, product code 134613, from Century Lubricants. If noise continues, check steering wheel and shroud (not applicable to columns with clockspring).

TEST #28**Steering Column Bearing**

Check upper bearing gaskets. Gaskets should cover bearing.

TEST #29**Intermediate Column Lash**

Check intermediate column (I-Shaft) for torsional lash in U-Joints of slip section. Replace intermediate column if necessary.

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Section 4 Comments

Comment A - H 36

Comment I - K 37

Comment A

Some power steering pumps have a temporary state during which the pumping element vanes do not extend. Usually increasing engine speed briefly will correct the problem.

Comment B

The maximum speed of steer with power assist for a power steering gear is limited by the pump flow and internal leakage. Example: Recommended minimum flow for a new TAS65 steering gear is 3.0 gpm (11.4 lpm), and is based on a maximum steering speed capability of 1.5 steering wheel turns per second.

Comment C

Vehicle linkages are designed to minimize the affect at the steering gear and steering wheel during normal steered axle/suspension movements. Be sure that linkage used is as specified by vehicle manufacturer.

Comment D

A single u-joint operating at an angle will cause a cyclic torque variation at the steering wheel. The amount of torque variation increases with the amount of operating angle. A secondary couple that side loads the input shaft also increases with increased u-joint angles. U-joint operating angles of 15 degrees or less will minimize the torque variation felt at the steering wheel.

Comment E

Deflections in the suspension and linkage, front and rear, due to high engine generated torque levels can cause a steering effect. This most often occurs at lower vehicle speeds while accelerating.

Comment F

The location of the axle arm ball center is important during spring wind-up conditions such as severe braking. A steering arm different from that specified by the manufacturer could cause a steering effect while braking.

Comment G

Soft or loosely supported rear suspensions may allow the rear driving axles to become non-square with the centerline of the chassis during load shifting or trailer roll which will tend to produce a steering effect.

Comment H

Power steering pump cavitation

Pump cavitation is defined as a "wining" or noisy power steering pump. Usually, pump cavitation is most noticed during engine start-up at low temperature extremes. However, other conditions can cause the power steering pump to continually cavitate and cause internal pump damage, and ultimately, failure. These conditions are:

1. Twisted, loose, or cracked inlet line
2. Inlet line blockage due to:
 - a. Contamination - dirt and foreign material
 - b. Damaged filters
 - c. Reservoir components
 - d. Inner hose liner separation
3. Displaced (improper or improperly installed) filters
4. Reservoir cap "vent" plugged

**Comment I**

Excessive Flow

TRW steering gears are rated for 8 gpm maximum power steering pump flow. Although the gears have the capability to handle this maximum flow, it is not always a system need or requirement. When using combinations of dual gears or a single gear with a hydraulic linear cylinder, supply flows for both components should be considered (See Steering Gear Flow Requirements). Single gear applications have a recommended flow at engine idle. For acceptable steering speed performance, again, refer to the Steering Gear Flow Requirements. Increasing the engine idle flow by more than 50% of the recommended flow can cause power steering system overheating, vehicle directional control problems (Darting), and steer axle returnability (Non-recovery). If you measure idle flows above the 50% limit, consult your OEM for guidance and recommendations.

Comment J

Flushing and Air Bleeding the System

IMPORTANT: Clean the area around the reservoir, steering gear and pump thoroughly before beginning this procedure.

1. Set parking brake on vehicle and block rear wheels.
2. Raise the front end off the ground
3. Take vehicle out of gear and put into neutral position
4. Raise hood and place a drip pan under the steering gear
5. Remove both the pressure and return lines from the steering gear
6. Remove filter from the power steering fluid reservoir and discard

IMPORTANT: Discard only the filter, other components may be required to hold filter element in place inside the reservoir.

7. Clean the inside of the reservoir
8. Turn steering wheel from full left to full right 3-4 times. This will purge the oil from the steering gear.
9. Reconnect pressure and return lines to the steering gear and tighten
10. Install new filter element into the reservoir
11. Clean reservoir filler cap with an approved solvent. Inspect gasket and replace if necessary.
12. Fill reservoir with approved replacement fluid and reinstall the filler cap
13. Start engine for 10 seconds, stop, and check reservoir fluid level and top off if necessary. You may need to repeat this procedure 3 or 4 times.
14. Upon completion of filling the reservoir, start the engine and let it idle. At engine idle, steer full right and full left once and return to straight ahead. Stop engine and check power steering reservoir level and top off if required.
15. Restart engine and steer full turns each direction 3 or 4 times.
16. Stop engine and recheck reservoir fluid level and adjust to correct level, if needed.
17. Inspect system for leaks and correct if necessary
18. Bleed air from the system if required (Refer to your steering gear service manual for recommended air bleeding procedures.)
19. Remove drip pan and lower vehicle. Remove blocks from wheels and release vehicle for normal service.

Comment K

Identifying "Burnt Oil"

Sometimes the power steering reservoir oil supply will become hotter than the normal operating temperature and overheat. This condition may result in an intermittent loss of power assist and also cause deterioration of the power steering hoses and component seals. TRW recommends that the power steering hoses be examined for deterioration due to overheated oil, which can be identified by wet hoses, and determine the condition of the reservoir fluid by looking for signs of "burnt oil."

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Section 5 Test Results

Test 5 - Power Steering Pump Test 40

Test 5.1 - 40 Minute Power Steering Pump Test 40

Test 6 - Flow Control Response Test 41

Test 6.1 - 40 Minute Flow Control Response Test 41

Test 10 - Restricted Hydraulic Line Test 42

Steering Gear Flow Requirements 43

Pump Part Number Reference Guide 44

Test 5.0 - Power Steering Pump Test

Relief Pressure: _____ PSI/BAR

Engine(RPM)	No Load	1000PSI
Idle		
1500		

Table 5.0

Test 5.1 - 40 Minute Power Steering Pump Test

Ambient	
Start	
10 Minutes	
20 Minutes	
30 Minutes	
40 Minutes	
Unit of Measure	°F or °C

Relief Pressure: _____ PSI/BAR

Engine(RPM)	No Load	1000PSI
Idle		
1500		

Table 5.1



Test 6.0 - Pump Flow Control Response Test

Unit of Measure	PSI or BAR	Unit of Measure	PSI or BAR
Pump Relief #1 (Idle)		Pump Relief #1 (1500 RPM)	
Pump Relief #2 (Idle)		Pump Relief #2 (1500 RPM)	
Pump Relief #3 (Idle)		Pump Relief #3 (1500 RPM)	

Table 6.0

Test 6.1 - 40 Minute Pump Flow Control Response Test

Ambient	
Start	
10 Minutes	
20 Minutes	
30 Minutes	
40 Minutes	
Unit of Measure	°F or °C

Unit of Measure	PSI or BAR	Unit of Measure	PSI or BAR
Pump Relief #1 (Idle)		Pump Relief #1 (1500 RPM)	
Pump Relief #2 (Idle)		Pump Relief #2 (1500 RPM)	
Pump Relief #3 (Idle)		Pump Relief #3 (1500 RPM)	

Table 6.1

Test 10.0 - Restricted Hydraulic Line Test

With PSSA @ 125 - 135 F (52 - 57 C)	RPM	GPM or LPM
With pressure gauge at pressure line to steering gear at pump end	RPM	GPM or LPM
Remove pressure and return lines and measure pressure with gauge at pump outlet	RPM	PSI or BAR

Table 10.0



Steering Gear Flow Requirements

Single Gear

Gear	GPM	LPM
TAS40, THP/PCF45, HFB52	2.2	8.3
TAS55, THP/PCF60	2.6	9.8
TAS65 or HFB64	3.0	11.4
TAS85 or HFB70	3.6	13.6
RCS40	2.2	8.3
RCS55	2.6	9.8
RCS65	3.0	11.4
RCS85	3.6	13.6

Dual Gear

Gear	GPM	LPM
TAS65 w/ RCS65	6.0	22.7
TAS65 w/ Linear Cylinder	6.5	24.6
TAS85 w/ RCS85	7.0	26.5
TAS85 w/ RCS65	6.5	24.6
TAS85 w/ Linear Cylinder	6.5	24.6
HFB70 w/ RCB70	7.0	26.5
HFB70 w/ RCB64	6.5	24.6
HFB70 w/ Linear Cylinder	6.5	24.6

Pump Part Number Reference Guide

Check the part number on your TRW power steering pump and note the pump relief setting shown in the example below. (See illustration on where to find the pump part number). If the values that you have recorded are within +/- 100 psi (+/- 7 bar) your pump is functioning properly. If the values recorded are below the negative tolerance, your pump is malfunctioning and should be replaced.

For TRW power steering pumps, the relief setting will be the 5th and 6th numbers in the pump part number.

EV 18 12 15 R 1 01 00

Family designation _____

PS = PS Pump

EV = EV Pump

Displacement per revolution _____

18 = 18 cc (1.10 cir)

22 = 22 cc (1.34 cir)

25 = 25 cc (1.53 cir)

28 = 28 cc (1.71 cir)

Flow control _____

12 = 12 lpm (3.17 gpm)

14 = 14 lpm (3.70 gpm)

16 = 16 lpm (4.23 gpm)

20 = 20 lpm (5.28 gpm)

24 = 24 lpm (6.34 gpm)

Relief setting _____

09 = 90 bar (1305 psi)

10 = 100 bar (1450 psi)

12 = 120 bar (1740 psi)

14 = 140 bar (2030 psi)

15 = 150 bar (2175 psi)

16 = 160 bar (2320 psi)

17 = 170 bar (2465 psi)

18 = 185 bar (2683 psi)

Direction of rotation _____

R = clockwise rotation

L = counterclockwise rotation

Shaft type _____

1 = 11 tooth 16/32 spline

2 = .625 dia. woodruff key

Housing _____

Varies between PS and EV Series pump

Customer version _____

00 = Standard





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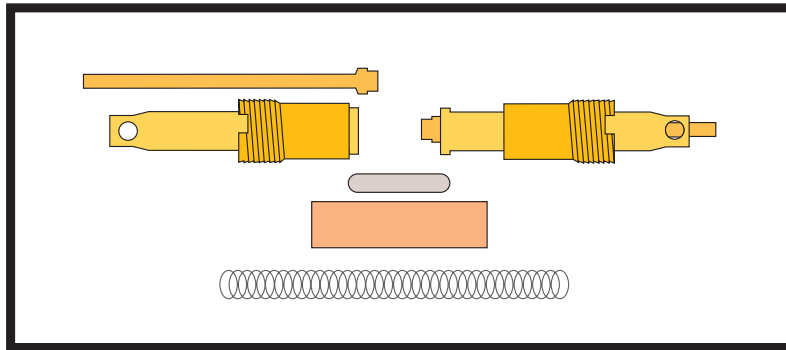
TRW1250 Rev. 4/02

**TRW**

TRW Automotive
Commercial Steering Systems

TAS Poppets

A Workbook and Self-Test
to be used with the
TRW TAS Poppet Setting Video



Follow all precautions and warnings in Service
Manual when setting or resetting poppets

What Poppets Are:

Poppets reduce pressure in full right and left turns

- Reduces hydraulic system heat
- Reduces force on linkage components

Pressure and heat build up in the steering system during turning maneuvers.

High temperatures can deteriorate the hydraulic system over time.

High pressure could put a lot of stress on linkage components over time.

How Poppets Work:

Rotating input shaft causes rack piston to move

Lower poppet in rack piston contacts fixed stop bolt or adjusting screw

Upper poppet in rack piston contacts valve housing

Contact of poppet and screw or valve housing pushes poppet away from it's seat.

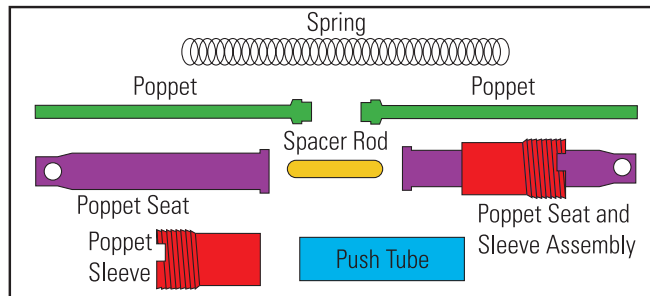
Gap between poppet and seat allows fluid to pass through the rack piston, reducing pressure.

Poppet should contact screw or valve housing just before axle contacts axle stop.



TAS Poppet Components:

- Two Poppet Seat and Sleeve Assemblies
- Two Poppets
- Spring
- Nylon Spacer Rod
- Push Tube



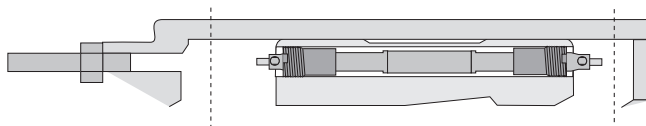
Setting poppets means pushing the poppet seat into the poppet sleeve. This backs off the poppet so it will contact the screw or valve housing just before axle contacts axle stop

TAS Factory Setting: (or New Aftermarket Gear)

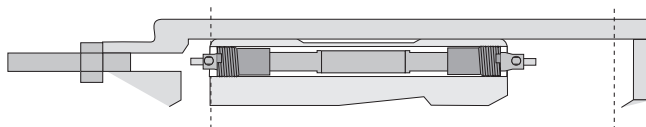
- Set axle stops
- Raise front axle
- Turn full right - engine on
- Turn full left - engine on

New steering gear poppet components look like this before setting. At this point, they are ready for automatic adjustment.

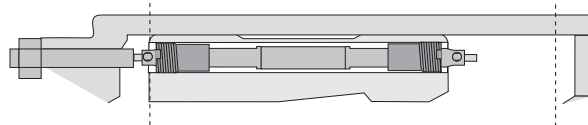
The amount of gear travel is determined on each vehicle by the axle stop settings. End of gear travel is marked in these diagrams by dotted lines. The rack piston will stop when it reaches these points because the axle stops will not allow the road wheels to travel further.



On the first full turn after installation on a vehicle, the poppet seat will make contact internally, and be pushed into the sleeve. Since the rack piston has travelled to its farthest point for the vehicle, the poppet seat, in its new set position, has also reached its farthest point of travel.

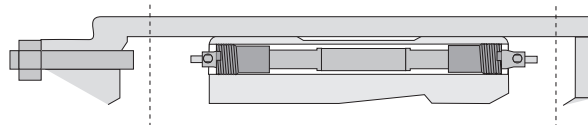


In the second full turn, the remaining poppet seat will be pushed in the amount required for that vehicle. Since the poppet seat and sleeve assemblies are a pressed fit, both poppet seats will now remain in this set position until they are reset using the procedure that follows.



Notice that the poppets were adjusted along with the poppet seat. In all subsequent turns, the poppet will be pushed off the seat to reduce pressure, and the poppet seat should never again make contact with the housing or the fixed stop screw.

When the poppet makes contact, pressure is reduced which also reduces the power assist felt at the steering wheel. Axle to axle stop contact can still be achieved, but with manual steering only.





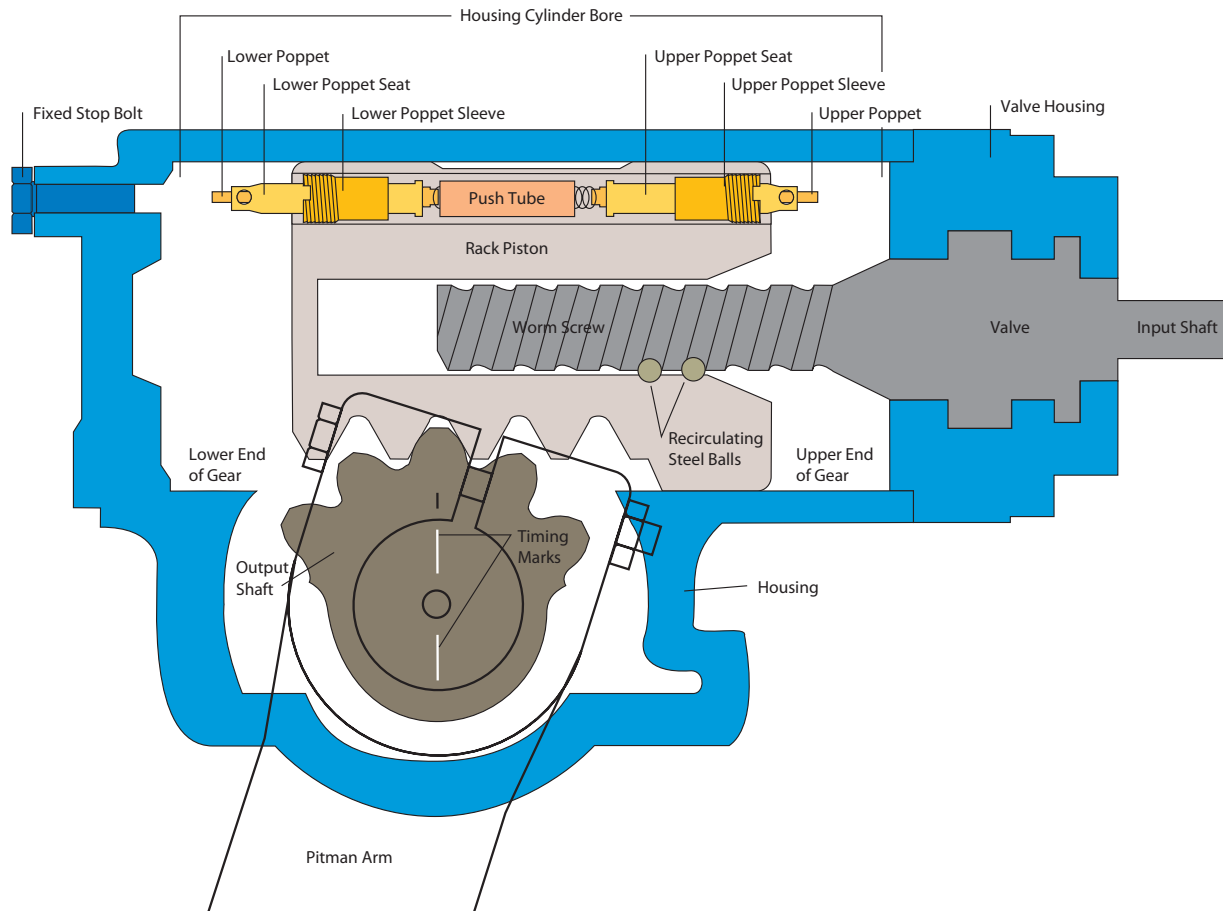
Reasons for Resetting Poppets:

- Changing to larger tires
- Reducing wheelcut for any reason
- If the steer axle u-bolts were bent or broken
- If the pitman arm was mistimed
- Axle stop bolts were damaged
- Steering gear is mounted on a different vehicle

TAS Resetting:

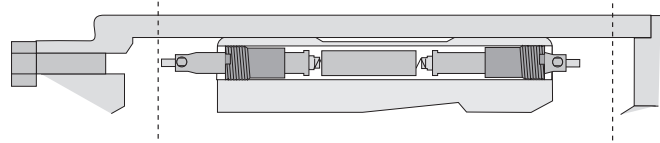
- Set axle stops
- Install adjusting screw
- Raise Front Axle
- Start Engine
- Turn in the direction that moves the inner output shaft timing mark toward adjusting screw
- Pull hard on the steering wheel
- Turn in opposite direction, pull hard on the steering wheel
- Turn off engine
- Back out adjusting screw until 1" is past the nut
- Start engine
- Turn steering wheel in original direction, pull hard when axle stop contact is made
- Screw in adjusting screw until it stops
- Back out adjusting screw 3 1/4 turns
- Torque jam nut
- Turn off engine, lower vehicle

Introduction to Internal Components

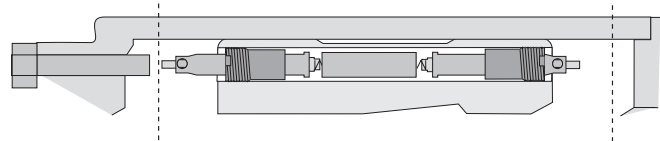




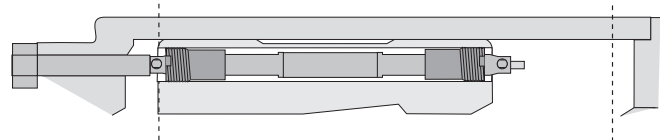
Axle stops have been reset in this diagram. They have been moved in, indicating that wheel cut has been reduced.



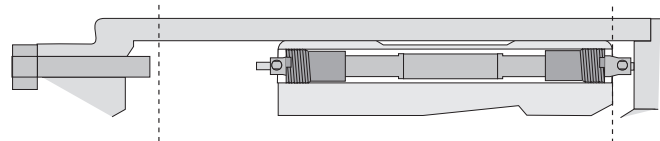
An adjusting screw is installed in the gear for the resetting process so the poppet components can be forced together to push on one another. Once the poppet components are pushed together, they will stay that way. The adjusting screw will also remain as part of the gear. Do not try to reuse the fixed stop screw after resetting poppets.



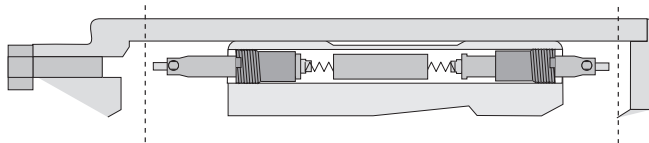
Turning in a direction that makes the rack piston move toward the lower end of the steering gear will force the lower poppet seat against the adjusting screw. The lower poppet seat then contacts the push tube and forces it against the upper poppet seat. This will force the upper poppet seat out so it can be set automatically on the next turn.



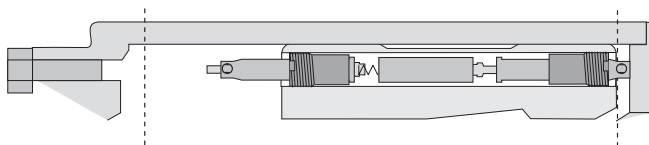
This turn sets the upper poppet seat in just the same way as it was set when the gear was new. Notice that since the poppet components are still forced together, the upper poppet seat is now forcing the push tube against the lower poppet seat to push it out.



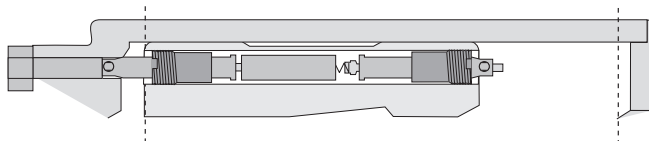
The adjusting screw is backed out of the way, so the poppet seat will not contact it on the next turn.



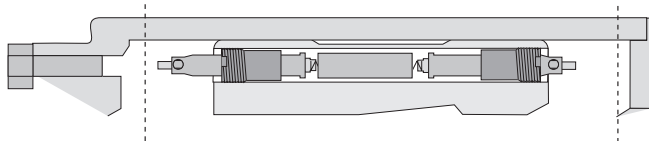
Holding the wheel at full turn places the poppet seat in the proper position for setting.



The adjusting screw is then turned in to meet the lower poppet seat and backed-out 3 1/4 turns.



The adjusting screw remains in this position, and acts as the contact point for the lower poppet until poppets need to be reset again.





Self-Test:

1. Poppets reduce system pressure:
 - A. After full turn
 - B. When axle stop contact is made
 - C. Just before full turn

2. Reducing pressure lessens:
 - A. Temperature in the hydraulic system
 - B. Stress on the linkage
 - C. Both

3. A good reason to reset poppets would be:
 - A. Wheelcut has been reduced
 - B. Loose Steering
 - C. Wheel kick

4. Always set axle stops before setting poppets.
 - A. True
 - B. False

5. If the sector shaft timing mark points toward the upper poppet, you should set the lower poppet.
 - A. True
 - B. False

Glossary of Terms:

Gear Families - TAS Family = TAS40, TAS55, TAS65, TAS85
(RCS cylinders are TAS gears without worm and valve).
HFB Family = HFB52, HFB64, HFB70 (RCB cylinders
are HFB gears without worm and valve)
HF Family = HF54, HF64

Linear Cylinder - A cylinder with a piston rod that provides in/
out thrust.

Lower End - End of cylinder bore farthest from the input shaft.

Master Gear - Main steering gear, located on driver's side of
vehicle.

Pressed Fit - The fitting of two components that allows a
controlled movement between them, but will not allow
them to move during normal operational actions.

Pump Relief Pressure - Maximum pressure of the power
steering pump.

Rim Pull - Force used to turn the steering wheel, measured in
pounds at the rim of the steering wheel.

Slave Gear - Auxiliary gear on passenger side of vehicle. Has
no worm screw, ball-nut mechanism, or control valve.

Steering System - Includes mechanical and hydraulic
components: steering wheel, column, u-joints, slip
joints, miter box, steering gear, pump, reservoir, hoses
and connections, pitman arm, drag link and sockets, axle
arm, king pin, bushings, tie rod arms and ends, steering
spindle, wheel bearings, springs and spring pin
connectors, spring hanger brackets, front axle, u-bolts.

Steering Wheel Travel - Number of times the steering wheel
can rotate between full turns.

Thread Engagement - The amount of contact between threads
on screw and nut.

Timing Marks - Use the output shaft timing mark nearest the
cylinder bore to judge which poppet to set.

Upper End - End of cylinder bore nearest the input shaft.



Answers to the Self-Test:

1. C
2. C
3. A
4. A
5. B

TAS Poppet Workbook

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